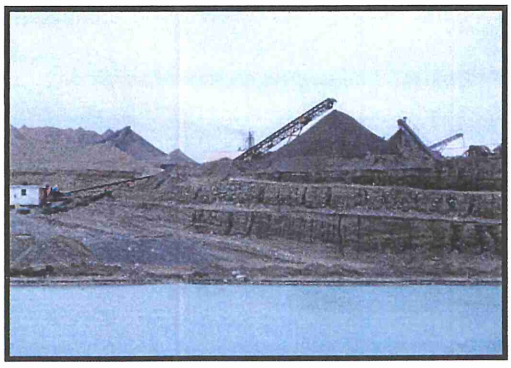
LCMR WORK PROGRAM 1999

PROJECT TITLE: INTEGRATED PRAIRIE MANAGEMENT
Ch. 231, Sec. 16, Sub. 7 d - (Agriculture and Natural Resource Based Industries)

FELTON PRAIRIE

STEWARDSHIP PLAN



The Felton Prairie Stewardship Committee gratefully acknowledges funding for this project from the Minnesota Legislature through the Legislative Commission on Minnesota Resources, ML 1999, Chapter 231, Section 16, subsection 7.

EXECUTIVE SUMMARY

The Felton Prairie Stewardship Committee was organized in 1997 as an outcome of the Clay County Beach Ridges Forum. Development of the stewardship plan was funded by the Minnesota Legislature as recommended by the Legislative Commission on Minnesota Resources (LCMR) in 1999. The plan addresses land use for approximately 3,000 acres of public land in northern Clay County, east of Felton, Minnesota. The LCMR grant also funded an aggregate resource evaluation completed in 2000 and the reclamation of an abandoned gravel mine known as the Zillmer site. Signs interpreting the prairie, gravel mining, and reclamation process have been installed at a public parking area and overlook developed at the Zillmer reclamation site. Below is a summary of the stewardship plan:

AGGREGATE RESOURCES:

1. The rotosonic drill study conducted for the Aggregate Resource Evaluation (MN DNR 2000) indicates a significant aggregate deposit running from the Clay County gravel pit north to the State School Trust Fund mine. The report estimates 24.1 million cubic yards (c.y.) of aggregate in the primary deposit, but not all of it is recoverable (page 29).
2. Much of this aggregate appears to be high quality and suitable for concrete production (page 29).
3. Electrical resistivity profiles conducted on Bicentennial Prairie SNA indicate significant aggregate resources in the northwest quarter but the quality and quantity could not be determined from this testing method (page 30).
4. Of the estimated 6.5 million c.y. of aggregate in the county pit, 3.3 million can be mined with a backhoe or dragline. Nearly all of the deposit is below the water table and must be mixed with fines (clay, silt) to make suitable road gravel. Based on the county's current annual usage rate (100,000 c.y.), the supply would last for 43 years, although the onsite supply of fines is estimated to last only 16 years (page 36).
5. The county currently purchases 150,000 c.y. of gravel per year of which 60,000 c.y. or 40% comes from the county pit. Thirteen northern townships also purchase gravel from the county pit (40,000 c.y. per year). To date, all mining has occurred above the water table and all material has been used for county and township road maintenance (page 34).
6. Mining below the water table in the county pit is estimated to increase the total cost of gravel purchased from this source by approximately 40%. The cost of this material would then equal the cost of purchasing road gravel from the private sector until local fines are exhausted. For the county, this will increase its annual, county-wide costs for gravel by an estimated 20%. If fines must be imported from another location to achieve a suitable road gravel mix, then costs of material from the county pit will exceed the private purchase price based on current knowledge and resource estimates (page 43).
7. If the current footprint of the county pit were leased to a private aggregate company for a royalty rate of $1.25 per yard, and this payment were deposited into a 'gravel endowment', the committee estimates a fund value ranging from $2.4 million to $20.6 million by the end of the pit's life (32-59 years depending on the mining alternative chosen), extraction rate (assumed 200,000 yds/yr for estimate), and interest rate. The sooner the pit is leased, the greater the return, provided these funds are applied exclusively to county gravel needs. This calculation assumes the county will need to mine below the water table or purchase gravel from the private sector in 2002 (page 43).
8. Preliminary estimates of the value of the county land if it were sold (excluding the county pit, but including Bicentennial Prairie) ranged from $2.8 - 7.5 million dollars. If this were invested at a conservative 4% APR, the fund would grow to $10.8 – 30 million dollars in 32 years (the shortest proposed lifespan of the county pit, page 44-45).

PRAIRIE RESOURCES:

1. The committee relied on data collected by the Minnesota DNR during the Clay County biological survey to determine the amount of native prairie remaining in the county. According to this survey the county has lost 97% of its original native grasslands (page 5).
2. A total of 1,425 acres of native prairie remain in the 2,900 acre study area; of that total approximately 337 acres have no formal protection and support several rare species.
3. The prairie communities in the study area support (pages 15-21):
    a. Federally threatened species: 1 plant,
    b. State endangered species: 2 butterflies and 1 bird,
    c. State threatened species: 1 butterfly and 2 plants,
    d. State special concern species: 3 butterflies, 3 birds, 1 mammal, 1 reptile, 8 plants.
4. Calcareous seepage fens, a rare type of wetland, are protected by state law and placed under DNR jurisdiction. Actions that will impact them require a fen management plan. Mining on School Trust Fund land is believed to have impacted the north fen in the study area. This resulted in a groundwater study conducted by the DNR Division of Waters (pages 24,32).
    a. The DNR fen study concludes that a 10' buffer must be maintained above the highest groundwater elevation.
    b. Mining north of the current county footprint and east could impact the fens and must remain above the 10' buffer.
    c. Mining below the water in the current footprint or south will not result in significant degradation to the fens.
5. Significant aggregate resources north of the county pit are below the fen buffer elevation and will require considerable planning, analysis, and potentially, mitigation costs before any mining could take place. Given the current regulatory requirements, it would be difficult to mine in this area (p. 32).

ISSUES:

1. Clay County has nearly exhausted surface supplies of road gravel within the boundaries of the county pit. Expanded surface mining will result in significant impacts to rare species and will incur DNR regulatory oversight. Mining below the water table will lead to increased costs.
2. The existing prairie resources are fragmented by mining activities and multiple management objectives of multiple owners. Five different entities manage the prairie resource without formal coordination of those efforts (private industry, MN DNR, Clay County, TNC, USFWS).

RECOMMENDATIONS:

1. The stewardship plan provides general management and land use recommendations for sub-units of the 2,900 acre study area (pages 51-87). These parcels were defined by ownership, land use, and gravel potential. The following land uses or activities were recommended:
    A. Aggregate mining - 232 acres, 8% of area (must reclaim after mining, but not included in percentage calculation below),
    B. Mine reclamation – 63 acres, 2% of area in the near future, 232 acres when mining ends on acreage identified above,
    C. Restore native vegetation – 681 acres, 23% of area,
    D. Preserve native communities, including fens, shrub swamps, and prairies – 1502 acres, 52% of area,
    E. Preserve or transfer ownership/management of native communities – 431 acres, 15% of area.
2. Develop mine plans for active aggregate operations that provide for progressive reclamation.
3. Use native species of local genotype, if possible, for all reclamation and restoration activities.
4. Obtain an appraisal from a licensed appraiser to determine the market value of county land based on the aggregate resources they hold. Explore the sale of land without environmental impediments and with aggregate resources for the endowment of a gravel fund that will provide for the county's future road gravel needs.

FELTON PRAIRIE STEWARDSHIP PLAN

Clay County, Minnesota

May 21, 2002

Felton Prairie Stewardship Committee:

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Peter Buesseler, Minnesota Department of Natural Resources, Division of Ecological Services
Cindy Buttleman, Minnesota DNR, Division of Land and Minerals
Jack Cousins, Clay County Engineering
Jon Evert, Clay County Board of Commissioners
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I. INTRODUCTION - Felton Prairie Stewardship Plan

This plan records the issues, analysis, and recommendations of the Felton Prairie Stewardship Committee concerning 2,900 acres of publicly held land east of Felton, Minnesota in Clay County (Fig. 1). Members of the committee include representatives of Clay County government, the aggregate industry, Minnesota Department of Natural Resources (DNR), Minnesota Department of Transportation (MnDOT), University of Minnesota at Crookston, Minnesota State University at Moorhead and The Nature Conservancy (TNC). The Felton Prairie Stewardship Committee continued the work of the Clay County Beach Ridges Forum after it concluded in 1997. The committee drafted a project proposal in 1998 for consideration by the Legislative Committee on Minnesota Resources (LCMR). They received funding in 1999 and held regular meetings from 1999 to 2001 to develop a stewardship plan. Their efforts and this document were funded in 1999 by the Minnesota Legislature as recommended by the LCMR. This grant also funded an aggregate resource evaluation used for planning purposes in this document and the reclamation of a depleted gravel pit in the area under consideration.

The purpose of the Felton Prairie Stewardship Plan is outlined in the funded work plan:

> "This project will result in a site-specific stewardship plan for *2900 acres* [*sic*] of public land within the Felton Prairie Complex with special emphasis on the 800 acres which may contain both prairie and gravel. The plan will provide for gravel mining, reclamation, prairie restoration and prairie preservation opportunities," (Felton Prairie Stewardship Committee, 1999).

A. Challenges & Opportunities

The need for this plan arises from land use conflicts. The origin of these conflicts will be described in greater detail elsewhere in this document; but in simple terms, it results from the co-location of valuable and scarce resources: native prairie and concrete-grade aggregate. Beneath portions of the prairie where endangered species breed and fulfill their life cycles lies high quality aggregate. If you mine the gravel, you eliminate the prairie and threaten or eliminate the species dependent on it. This is one example of the many linkages that exist at Felton Prairie. The stewardship committee identified these challenges:

1. Conflict between biological resource protection and society's need for aggregate,
2. Effects of multiple property owners on management coordination,
3. Meeting Clay County's aggregate needs for road maintenance.

Along with the challenges, the committee has identified these opportunities:

1. Realize the economic value of the county's gravel deposit;
2. Reclaim abandoned spoil piles and gravel pits;
3. Preserve native grassland communities and restore disturbed land;
4. Coordinate management efforts for native grassland communities and rare species;
5. Improve the potential for eco-tourism in the area. (Insufficient time was available to develop this opportunity in the plan.)

In order to address these challenges and opportunities, the Felton Prairie Stewardship Committee met from 1997-2001 to propose and develop a stewardship plan for public lands in Felton Prairie. The term "stewardship" is used rather than "management" for a number of reasons. First, given the challenges and opportunities listed, the committee needs to view the area holistically from economic, social, and ecological perspectives. The term "stewardship" evokes a longer time horizon than "management" and requires less specificity in recommendations. It also implies the custodial responsibility we have in the present to provide for generations in the future. How can the resources, both mineral and biological, be managed or balanced for the long-term benefit of citizens in Clay County and the state of Minnesota?

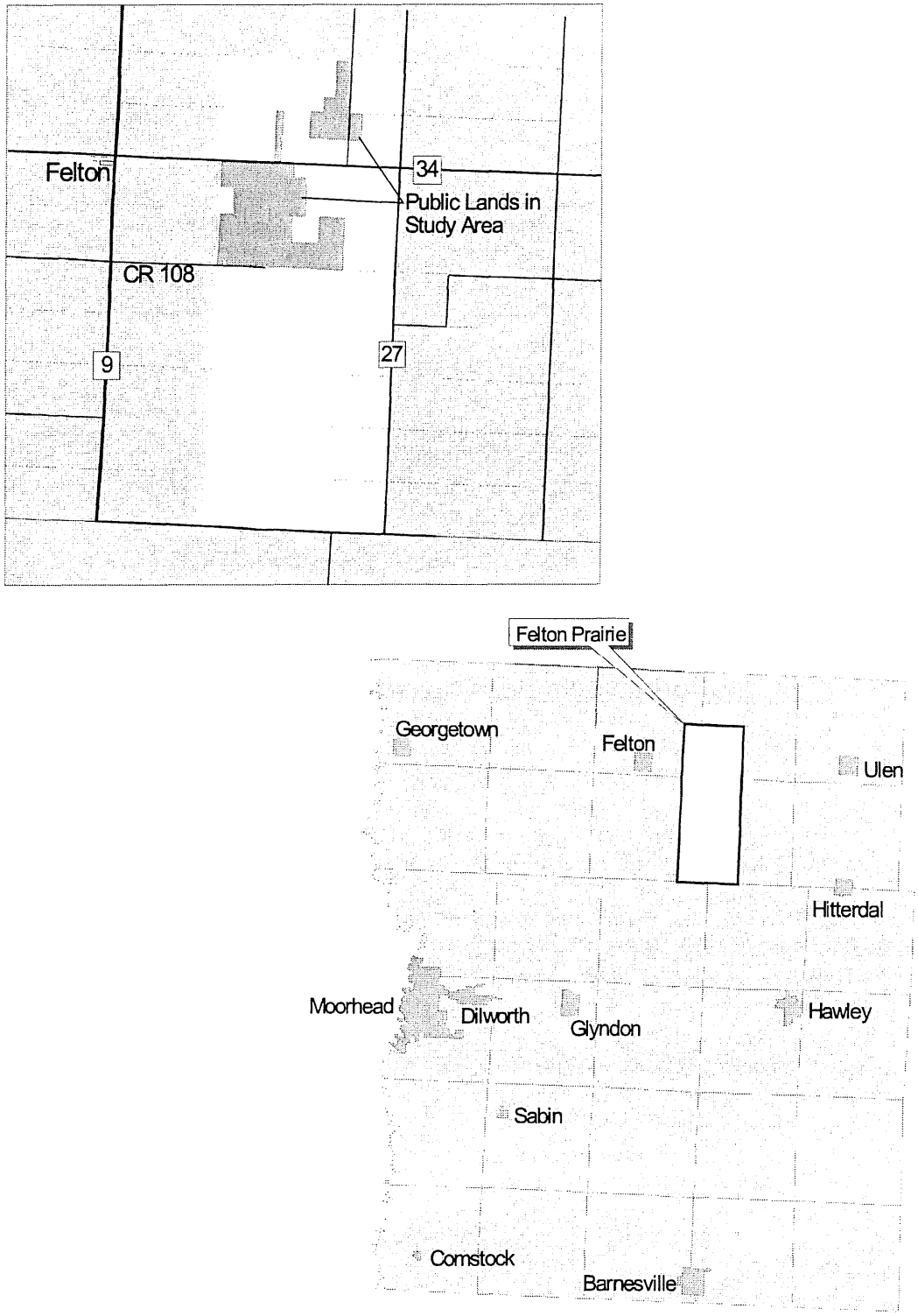

Figure 1: Location of Felton Prairie area in Clay County (below) and cluster of public lands found in the study area (above).

The stewardship plan recommends land use activities for the parcels identified in Figure 2. All of these lands are owned or managed by public entities, specifically Clay County, the Minnesota Department of Natural Resources (MN DNR), and the United States Fish and Wildlife Service (USFWS). Clay County owns the aggregate mining site labeled "A" in Figure 2. From it they supply road gravel to maintain county and township owned roads. The Nature Conservancy owns Blazing Star Prairie and manages it as a Scientific and Natural Area (SNA) in partnership with DNR. DNR also manages State School Trust Fund lands to generate income for education funding. Aggregate Industries leases and mines the aggregate on State School Trust Fund land (labeled B) in Hagen Township. The U.S. Fish and Wildlife Service (USFWS) holds a conservation easement on the DNR property (Flowing Township, Section 1) known as the Zillmer site. With the exception of USFWS, all of these entities have representatives on the committee and all have had an opportunity to provide information and advocacy for different points of view. The activities recommended by this plan for these lands will include aggregate mining, aggregate mine reclamation, prairie restoration, and preservation consistent with the LCMR project proposal. Unlike a traditional management or mining plan, a plan of action and maintenance will not be covered by this document. The owners and managers of these resources are ultimately responsible for management and utilization of these resources. The committee's recommendations reflect the interests of all parties involved but implementation responsibility and coordination rests with the public landholders.

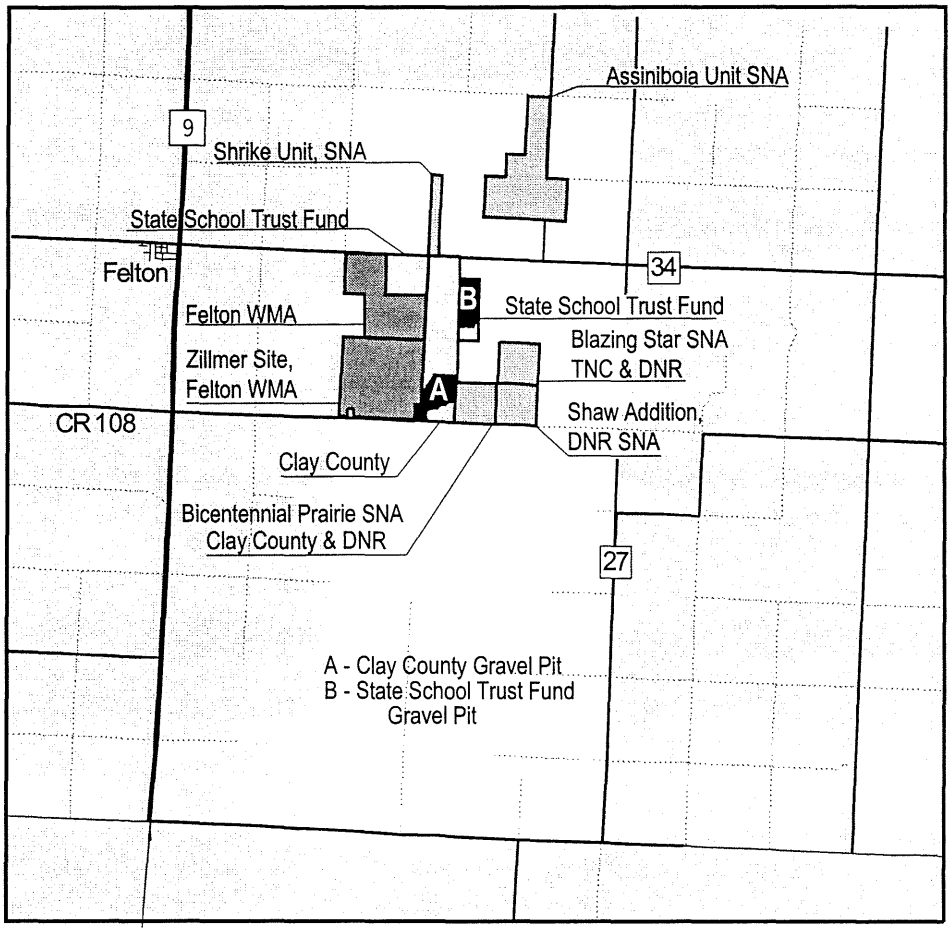

Figure 2: Public lands in study area; the area labeled (A) is the Clay County gravel pit, and (B) is the State School Trust Fund site leased to Aggregate Industries (formerly Camas) for mining gravel.

B. Clay County Beach Ridges Forum

Concern for the future of prairie lands and aggregate mining in Clay County was addressed by the Beach Ridges Forum organized in 1995 by DNR and funded by LCMR. A series of meetings were held from January 1996 to June 1997 for anyone interested in prairie or aggregate resources in Clay County. Participants represented prairie preservation interests, the aggregate industry, private landowners, and units of government. The prairie and aggregate resources in the county were compiled and analyzed using a geographic information system and the participants were able to discuss their concerns and ideas in a neutral setting. Their mission was:

> "To identify and recommend ways to achieve a balance between the protection of our natural prairie heritage and environmentally yet economically sound gravel mining opportunities through appropriate land use management," (MN DNR, Report, 1997).

The Forum identified Felton Prairie as having high gravel potential as well as 40% of the high to medium biodiversity prairie found in the eastern part of the county based on the biological survey data. The document recognizes that Felton Prairie "represents the best and largest example of dry prairie remaining in the state," (MN DNR, Report, 1997).

The Forum concluded with a series of general recommendations that pertain to this stewardship plan:

- Maximize utilization of aggregate resources whenever possible;
- Sample aggregate deposits to identify the presence of economically valuable deposits on certain public lands to assist in long-term management;
- Reclaim abandoned gravel mining sites on both private and public lands;
- Develop mining and reclamation plans for active operations on both private and public lands;
- Promote the concept of progressive reclamation whenever possible;
- Use prairie grasses and forbs for gravel pit reclamation whenever possible;
- Acknowledge the ongoing need to work in partnership to continue the efforts begun by this Forum.

And a specific action item directly affected Felton prairie:

> "The Forum recommends that a proposal be written and funding sought for a rotosonic drilling program to be conducted on certain public lands within the Felton prairie with high quality prairie on the surface to determine the presence of an economically-recoverable aggregate resource," (MN DNR, Report, 1997).

The Felton Prairie Stewardship Committee should be viewed as a continuation of the Beach Ridges Forum with the specific intention of developing a land use plan for 2,900 acres of public land in Felton Prairie. The committee applied for and received an LCMR grant funding the plan, the rotosonic drill study, reclamation of the depleted mine on the Zillmer site (acquired by DNR in 1991) and development of an interpretation site for the public.

C. Planning Process

The Felton Prairie Stewardship Committee met on a regular basis to review the data available on aggregate and biological resources. Needing more information, the committee oversaw a rotosonic drill study and obtained additional information on rare seepage wetlands found in the study area. They have followed the same basic steps of inventory, analysis, formulation of alternatives, impacts, and recommendations as a traditional planner would, but in a less formulaic, prescribed manner. Conflicting issues were debated openly by those concerned with prairie preservation and those involved with gravel mining in the area. The process may have taken longer than a traditional plan but it embodies the compromises and opinions of a diverse group of advocates.

II. BACKGROUND

Land use issues for Felton Prairie are bound up in the geology and history of the region. When large numbers of settlers arrived on the prairies of Clay County in the late nineteenth century, they settled on the dry uplands of the beach ridges. At the turn of the century, construction equipment advanced to the point where the wet soils covering the Red River Valley floor could be drained for crop cultivation. These soils were formed by sediment transported into a large glacial lake that occupied the western two thirds of Clay County. Lake Agassiz formed 11,000 years ago as glacial ice retreated north. Bounding the lake east and west were beach ridges of sand and gravel. The native prairie plants adapted to the ridges were cut for hay or used for pasture. Because they were less desirable for cultivation compared to the ancient lakebed, the beach ridges support some of the finest native prairie left in the state of Minnesota, especially dry prairie, a community rarely found east of the great plains region. Of the estimated 614,500 acres of wet and tallgrass prairie that covered Clay County, only 18,500 remain (3%) as shown in Figure 3, (MN DNR, CD-ROM, 1997).

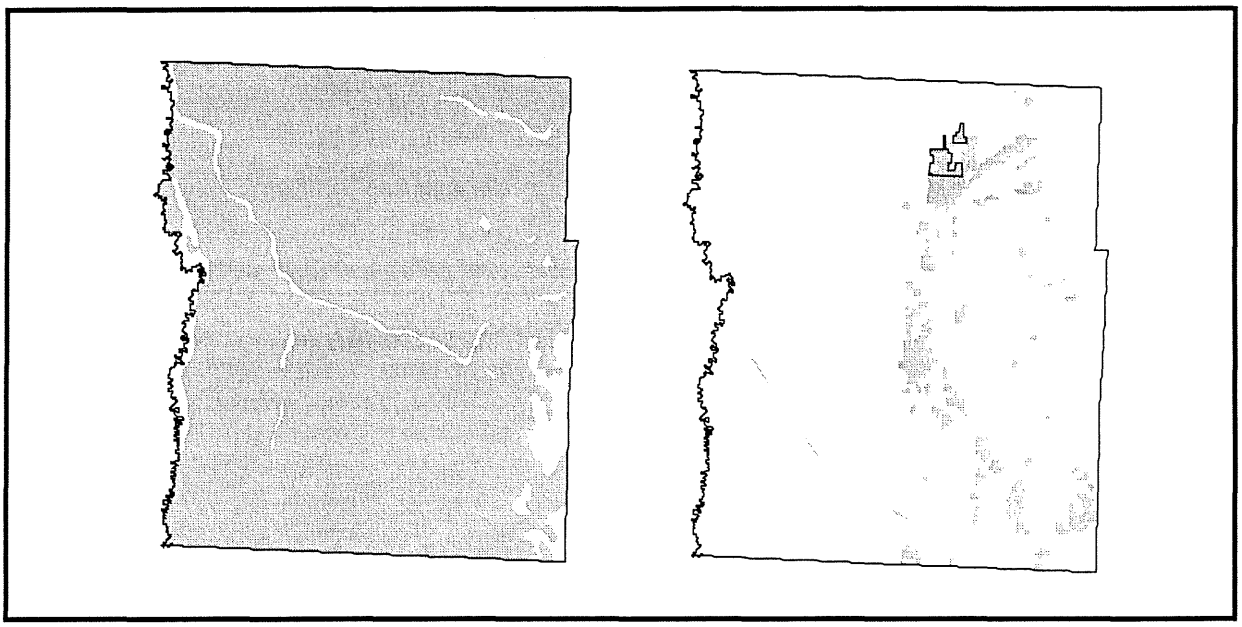

Figure 3: Estimated pre-settlement prairie found in Clay County shaded in gray, left, and what remains, right; the study area is outlined in black (MN DNR, CD-ROM, 1997).

The beach ridges are vital to economic development in the Fargo-Moorhead area because they hold the highest quality and most accessible quantity of aggregate in the region. The aggregate operations near Felton are within 20 miles of the Fargo-Moorhead metropolitan area. Although good for agriculture, the lakebed soils are not good foundation material for buildings and infra-structure like roads. They have a high shrink-swell range and are poorly drained. The gravel and sand from the beach ridges is used for construction materials like concrete and asphalt, and to provide drainage under roads and building foundations. The Red River Valley is rated by the United States Geological Survey (USGS) as an aggregate poor region (USGS, 2001). The beach ridges offer the best source of sand and gravel in the Red River valley. The aggregate industry has also provided an important source of economic diversification and income for the region.

With the introduction of the automobile around 1903 and passage of the Federal-Aid Highway Act in 1916, road construction and the use of concrete gradually increased. In the 1930's highway engineers recognized the need for a gravel sub-base, especially in high shrink-swell soils like those in the Red River Valley. When the 1956 Federal-Aid Highway Act was passed, creating the interstate system, the demand for concrete soared nationally (American Concrete Paving Association, 2001). The post-war boom led to a similar demand in the construction industry for materials including gravel and concrete. A study of aerial photographs of the Felton area will reveal that there was little to no aggregate mining at the turn of the century. The number of mine sites increased slowly after the depression and boomed during the post-war period along with improvements to and paving of roads in the region. The use of concrete for bridges and architectural structures also increased during the same period. These trends are likely to continue as the region grows and maintains its infrastructure. Ironically, it was the success and visibility of gravel mining that led to some of the earliest efforts to conserve Felton Prairie.

A. History of Felton Prairie Conservation Activities

Concern about the future of Felton Prairie dates back nearly fifty years in documented form. In 1953 a DNR Wildlife Supervisor proposed acquisition of 893 acres in Sections 36, Felton Township, 31 and 32, Hagen Township (Figure 4). In supporting documentation for prairie preservation, D.B. Lawrence wrote:

> "Felton Prairie has been examined...and all have been thrilled with its magnificence. It is a spectacular prairie with well exposed remnants of the shorelines of Glacial Lake Agassiz and portions of the pioneer wagon trail still plainly visible. From the high ridges there is a fine view westward out across the floor of the Red River Valley," (Lawrence, 1962).

Of the 893 acres, Clay County approved 320 acres for the Felton Wildlife Management Area (WMA). Part of Lawrence's proposed acreage (Sections 31 in Hagen Township and 6 in Keene) was deeded from the state to the county through tax forfeiture in 1945. According to the deed the property was to be used "exclusively for gravel pit – to obtain gravel for use on county highways," (Clay County, 1945). The county began mining in the current site shortly after acquisition of the property.

In 1975 The Nature Conservancy acquired the northeast quarter of Section 5 in Keene Township with financial support from Al Bloomquist and the Red River Valley Sugarbeet Growers Association. Blazing Star Prairie was dedicated as a State Scientific and Natural Area (SNA) in 1976 along with Bicentennial Prairie, a parcel leased to DNR by Clay County after vigorous debate. Boy Scout Troop #627 of Moorhead petitioned the board of commissioners to preserve 160 acres of native prairie owned by the county in Keene Township (SW ¼, Section 5). The land harbored prairie chicken booming grounds, Native American artifacts, and a large erratic boulder used as a rubbing stone by bison. After lengthy debate and petitions "for" preservation (500), and "against" (200), the county commissioners granted a ten-year, self-renewing lease to DNR as a State Scientific and Natural Area with the stipulation that the county could end the agreement in 90 days if they needed to mine aggregate on the site. A broad constituency formed to support the easement including the American Crystal Sugar Company, the Roamers 4-Wheel Drive Club, the Minnesota Prairie Chicken Society, Clay County 4-H, and the Center for Environmental Studies, a Tri-College consortium (Forum, 1975). Since that time both sites have been studied extensively and support several rare species such as the western prairie fringed orchid and the greater prairie chicken.

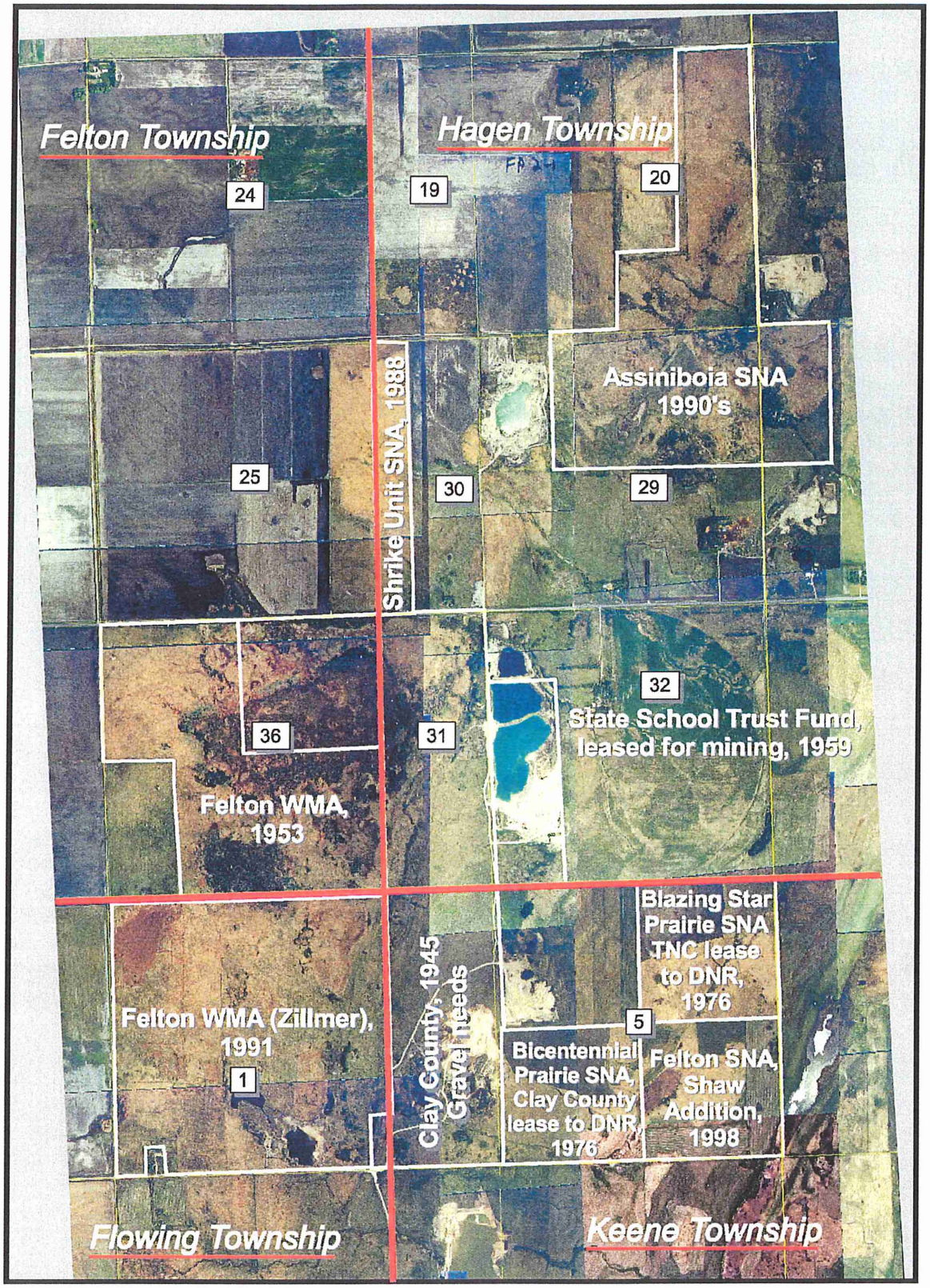

Figure 4: Summary of conservation activities and land agreements in the study area.

Immediately south of the Felton WMA, the U.S. Fish and Wildlife Service acquired an easement protecting Section 1 of Flowing Township in 1990 through foreclosure procedures by the Farmer's Home Administration. In 1991 DNR acquired the land. Shrike and Assiniboia Units, north of Highway 34, were added to the system of Scientific and Natural Areas in the 1990's. The most recent acquisition has been the Shaw property east of Bicentennial Prairie SNA secured in 1998. DNR held a prairie bank easement on 80 acres of the quarter section dating back to 1989. All of these efforts attest to the importance, and occasional controversy, of the prairie lands near Felton.

B. Issues

The stewardship plan must address the following issues in order to be credible and acceptable to the parties that must implement it.

1. Aggregate Supply for Local and Regional Needs

The end product of this planning process should provide guidance in resolving land use conflicts between prairie preservation and gravel mining for the immediate future. Both are scarce and valuable resources. The problem is that gravel cannot be mined without destroying the prairie and the conditions that supported it. Topography, hydrology, and soil structure will be altered to the point where certain species cannot be restored. On the other hand, prairie offers less economic return in the short run than aggregate mining. Aggregate has been mined primarily for concrete on the state school trust fund land since 1963. To date, approximately four million cubic yards have been mined yielding the fund $2.2 million in royalties. Clay County owns a gravel pit that supplies Class 5 road gravel for 600 miles of road maintenance on an annual basis. If mining were to cease, where would this material come from and how much would it cost to procure elsewhere?

2. Impact of Aggregate Mining on Biological Communities:

a) Loss and Fragmentation of Prairie Habitat

As seen in Figure 3 less than 3% of the presettlement prairie remains in Clay County. Of this, 14,290 acres occur in sites that have been ranked by the DNR as having high or medium biodiversity significance (MN DNR, CD-ROM, 1997). Figure 3 also illustrates the lack of connection among extant prairie remnants. Prairie species accustomed to vast, unbroken landscapes have become isolated populations on islands of prairie remnants. This fragmentation makes those populations more vulnerable to extirpation by disease, predators, and other forms of disturbance. Gravel mining is one such form of disturbance. Not only is the plant community removed, the act of mining may destroy eggs or individual species unable to escape. In addition, the soil or overburden that may lie above a gravel deposit is stored in a spoil pile. Without proper management such as weed control or a cover crop, invasive species like Canada thistle and spotted knapweed can colonize spoil piles and spread to the surrounding landscape.

b) Impacts of Mining below the Water Table on Calcareous Fens

Another issue emerged during the planning process that was not included in the original LCMR funding proposal. The north calcareous fen downslope of the State School Trust Fund mine exhibits signs of degradation. Woody vegetation has encroached on the fen indicating reduced ground water delivery to the site or a lack of prescribed burning. Another, larger fen referred to as the south fen does not exhibit the same degree of degradation. This led DNR to monitor local ground water levels in the 1990's. Calcareous seepage fens are unique, groundwater-fed wetlands. DNR has been collecting data from monitoring wells in order to understand the hydro-geologic conditions supporting the fens. Preliminary analysis of these data led to concerns that mining gravel below the water table could

impact the fens by altering ground water flows to them. Thus an initial solution to minimize prairie disturbance by deep mining could negatively impact the fens.

3. Regulatory Environment

The unique qualities of Felton Prairie may be viewed as assets for eco-tourism and promotion of the area, but for the mining industry they present additional challenges from federal and state protection of species such as the western prairie fringed orchid and Dakota skipper. The former is on the federal threatened species list which restricts actions that would harm or destroy the plant. A number of other species are state listed as endangered[1], threatened[2] or special concern[3] and any action that would cause the mortality of individuals of a listed species requires a state permit and mitigation. The calcareous fens, described above, are protected under the 1991 Minnesota Wetlands Conservation Act (MWCA):

> "Calcareous fens may not be drained or filled or otherwise altered or degraded except as provided for in a management plan approved by the commissioner. The commissioner will provide technical assistance to landowners or project sponsors in the development of management plans." (M.R. 8420.1040)

Because of their rarity and fragility, these fens are the only wetland type regulated by DNR, all others are overseen by the Minnesota Board of Water and Soil Resources.

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[1] Under Minnesota Statute 84.0895, Protection of threatened and endangered species, endangered is defined as a species "threatened with extinction throughout all or a significant portion of its range."

[2] Under Minnesota Statute 84.0895, threatened is defined as a species "likely to become endangered within the foreseeable future throughout all or a significant portion of its range."

[3] Under Minnesota Statute 84.0895, "species of special concern" is defined as "extremely uncommon in this state, or has unique or highly specific habitat requirements and deserves careful monitoring of its status. Species on the periphery of their range that are not listed as threatened may be included in this category along with those species that were once threatened or endangered but now have increasing or protected, stable populations."

III. PRAIRIE RESOURCE CONSIDERATIONS

A. Prairie Resources Inventory

Felton Prairie is part of the tallgrass prairie ecosystem. At one time this grassland (Fig. 5) spanned 148 million acres from Manitoba to Texas (Samson, 1996). The boundaries of tallgrass prairie shifted in response to disturbances such as climate fluctuations and fire frequency. During periods of abundant rainfall and lower fire frequency, the tallgrass prairie reverts to woodland. After Euro-American settlement, agriculture became the dominant land use. Even those areas where the prairie escaped the plow, fire was suppressed and many of the native grazers like bison were eliminated. As a result, only 4% of the native tallgrass prairie remains. These areas are widely scattered and relatively small in size compared the historic range of tallgrass prairie. Biologists refer to this condition as fragmentation. In Minnesota an estimated 18 million acres of prairie covered the landscape prior to settlement. In 1994 only 75,000 acres remained in the state, a loss of 99.6% (Samson, 1996).

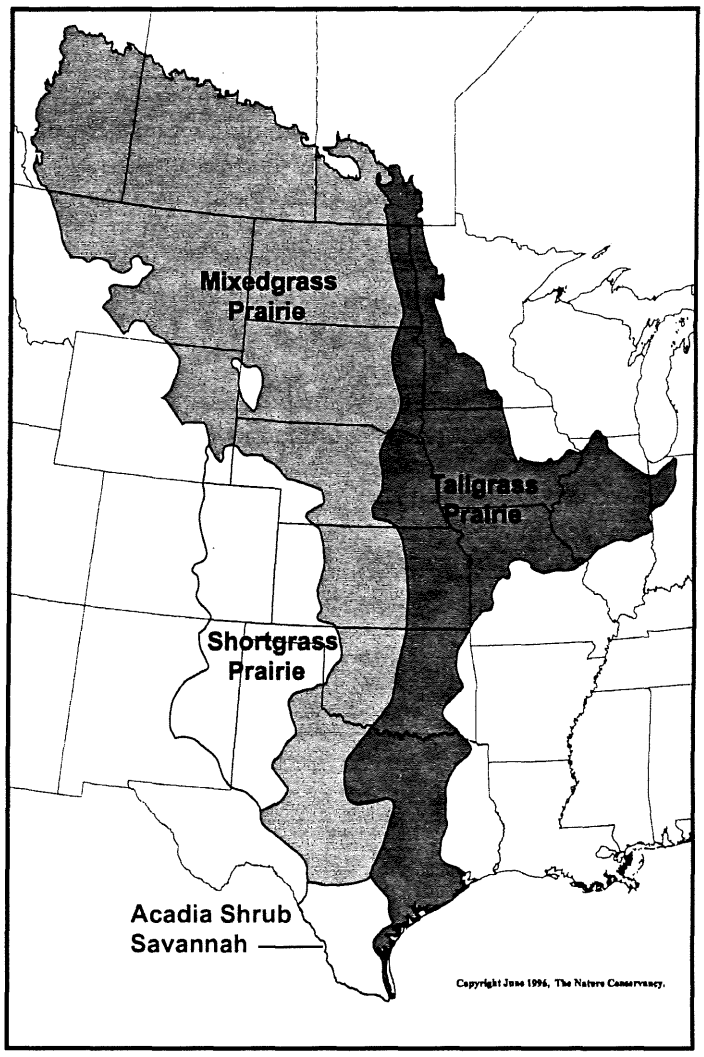


Figure 5: Prairie provinces of the United States. (Source: The Nature Conservancy)

Biologists have identified three "landscapes of significance" in our region (Samson, 1996): the Sheyenne Delta in North Dakota, the Lake Agassiz beach ridges in Minnesota, and the Tallgrass Aspen Parkland in northwest Minnesota and southern Manitoba (Figure 6). The Lake Agassiz beach ridges run along the eastern side of the Red River Valley and cross into the Aspen Parklands. They are collectively referred to as the Agassiz Interbeach area. Landscapes of significance are recognized where "significant amounts of natural vegetation and concentrations of rare species" exist, or high quality examples of native communities can be found (Samson, 1996). The identification of significant landscapes is based on a biodiversity assessment. "The flora and fauna of the Agassiz Interbeach Area (and the Plains region as a whole) is largely a derivative one, recruited from adjoining regions. Despite this attribute, it is the many unique combinations of species (natural communities) that significantly enhance the biodiversity of these regions relative to other geographic regions," (Ostlie, 1997). Felton Prairie exemplifies this richness of habitat. Within a few hundred yards vegetation will transition from lush wetlands to dry prairie as a beach ridge rises in elevation. Swales between the ridges of historic shorelines feature rich microclimates ranging from wetlands to mesic prairie, depending on the

elevation and local hydrology. Felton Prairie is a complex ecological mosaic of grasslands, wetlands, and shrub communities (Table 1) and is home to several rare and endangered species.

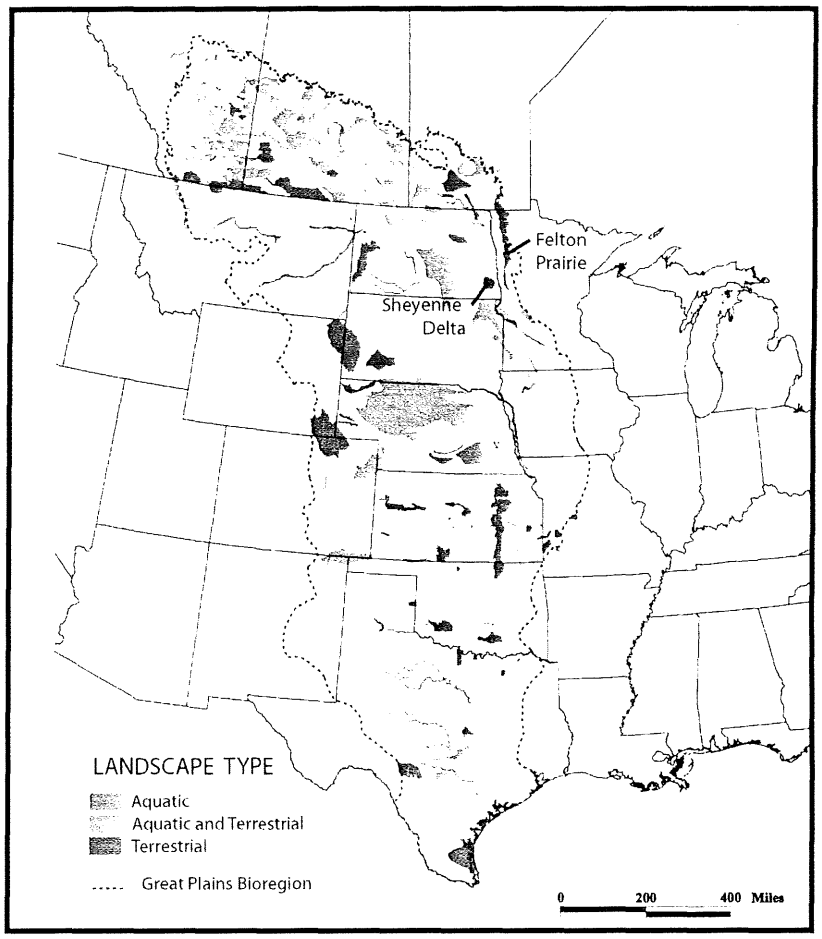


Figure 6: Significant landscapes of the Great Plains shown in gray. (Source: The Nature Conservancy)

Land Cover of Study Area	Number of Acres	Percentage of study area
Cultivated land & Grassland-Pasture	900	31%
Wet prairie	741	26%
Mesic prairie	497	17%
Shrub swamp	292	10%
Aggregate mining	214	7%
Dry prairie	151	5%
Mixed emergent marsh	91	3%
Calcareous seepage fen	20	1%
Total	**2906**	

Table 1: Breakdown of community and land use type in the study area (MN DNR, CD-ROM, 1997).

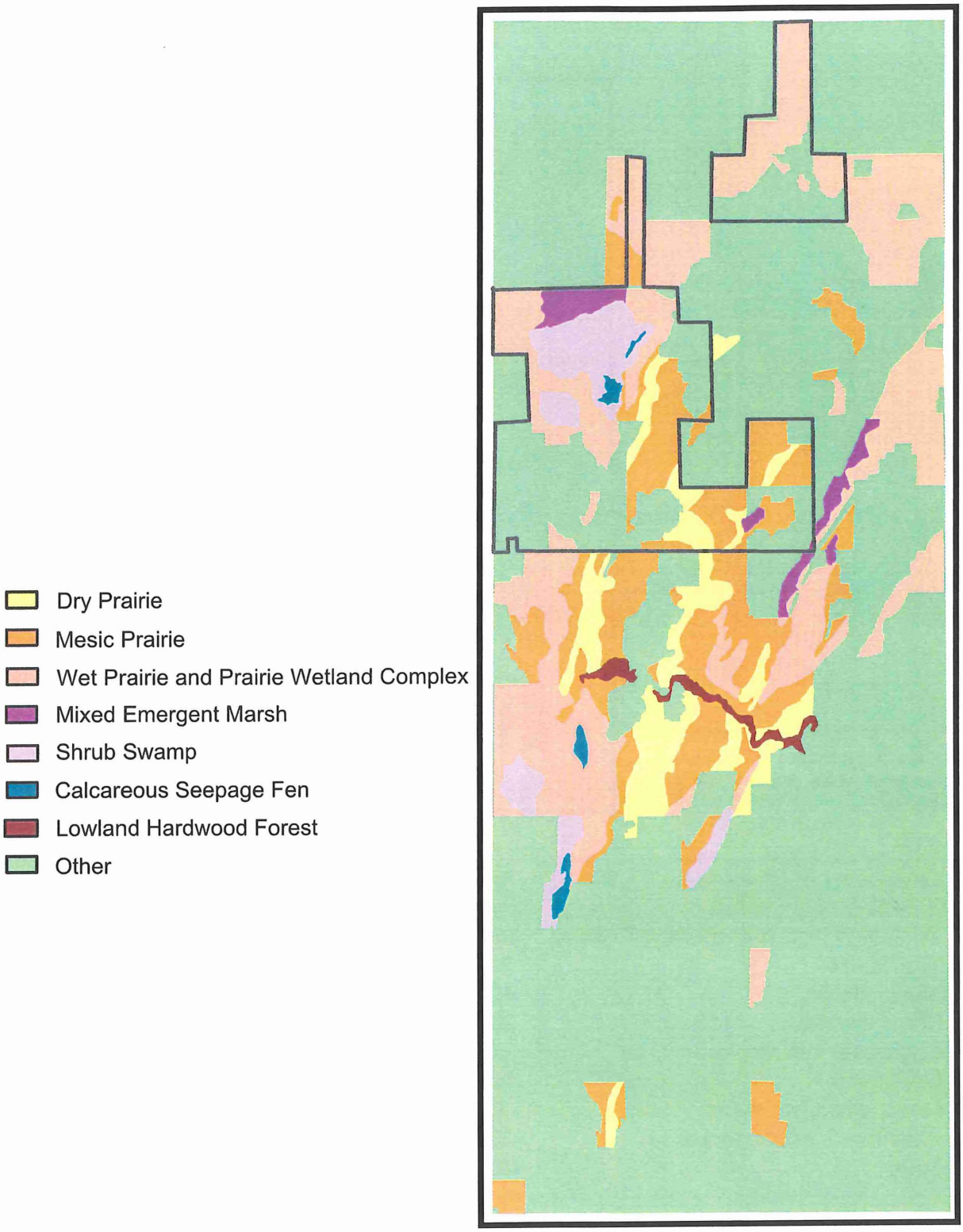


Figure 7: Composite view of the plant communities in the Felton area. (Source: MN DNR, CD-ROM, 1997)

1. Dry Prairie

This community covers approximately 7% of the Felton area and 5% of the study area (Fig. 8). It dominates the gravelly beach ridges and transitions into mesic prairie on side slopes and where the soils consist of finer particles. Felton Prairie is considered to be the finest example of dry prairie north of the Minnesota River in the state and is significant for the species dependent on it including several that are endangered or threatened. Plants of special concern include red three-awn grass (*Aristida purpurea var. longiseta*), plains reed grass (*Calamagrostis montanensis*), blanket flower (*Gaillardia aristata*), Hooker's wild-oat grass (*Helictotrichon hookeri*), dry sedge (*Carex xerantica*), and clustered broom-rape (*Orobanche fasciculata*). It is critical habitat for Uhler's arctic and Assiniboia skippers, chestnut-collared longspur, and prairie vole. This community is also used by the Dakota skipper, Powesheik skipperling, Pawnee skipper, and regal fritillary. In a report prepared by DNR on Felton Prairie, the dry prairie is described as, "mid-height and low bunch grasses and sedges, little bluestem, plains muhly, needle and thread grass, Wilcox's panic grass, prairie Junegrass, prairie dropseed, and threadleaf sedge are frequent, and three western grasses uncommon to rare in Minnesota, Hooker's spike oats, red three awn, and plains reed grass are occasional to scarce." (MN DNR, 1985)

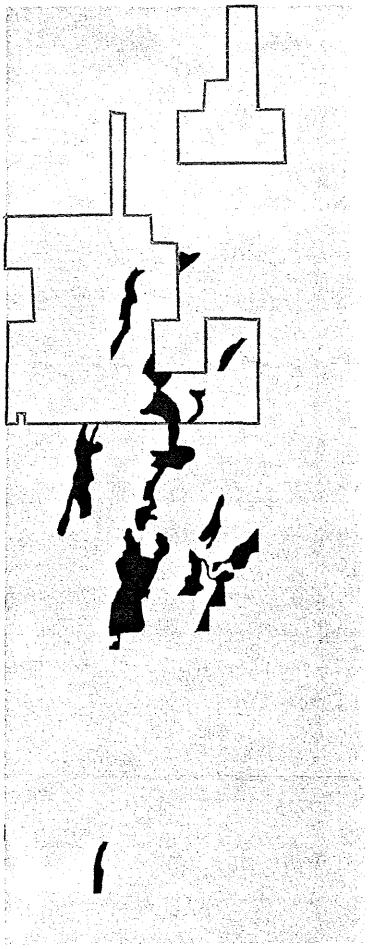


Figure 8: Areas of dry prairie in dark gray. (MN DNR, CD-ROM, 1997)

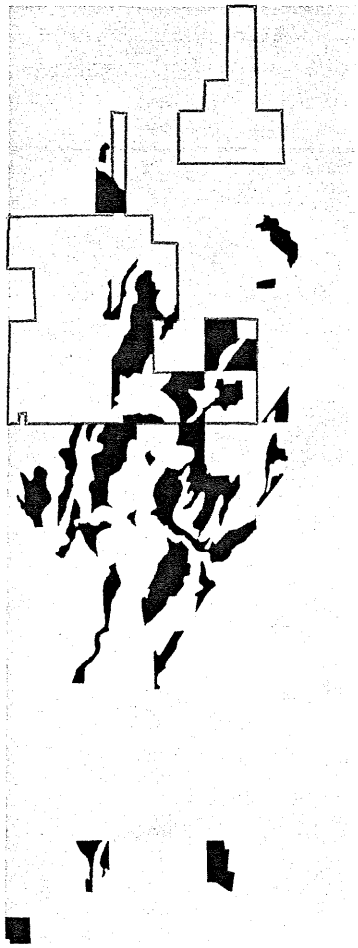


Figure 9: Areas of mesic prairie in dark gray. (Source: MN DNR, CD-ROM, 1997)

2. Mesic Prairie

Mesic prairie covers 17% of the study area and 8% of the Felton area (Fig. 9). This prairie type covers a wide band of moisture conditions with subtle gradations in plant composition and dominance. Found on ridge side slopes and in swales between the beach ridges, the DNR report describes it this way: "the undisturbed dry mesic phase here was dominated by porcupine grass, little bluestem and perhaps side oats grama....The mesic phase of this community was dominated by tall-grasses, big bluestem, indian grass and switchgrass, with porcupine grass, side oats grama, little bluestem, and prairie dropseed as important secondary components. Only the tallgrasses and prairie dropseed overlapped into the wet mesic phase, whose other major components included prairie cordgrass, northern reedgrass, and several sedges." (MN DNR, 1985) Species dependent on this community include small white lady slipper, Dakota skipper, Powesheik skipperling, Pawnee skipper, and regal fritillary.

Prairie Resources

3. Wet Prairie

This community dominates in the deep swales between beach ridges and where the western ridges grade into the ancient lake plain. Within the Felton study area small depressions or swales between the dry ridges support prairie cordgrass and sedges, along with bluejoint, northern reedgrass, and various rushes. The federally threatened western prairie fringed orchid may be found in this habitat and several birds including the upland sandpiper, and marbled godwit utilize it for feeding. Wet prairie comprises 24% of the study area and 10% of the Felton area as a whole (Fig. 10).

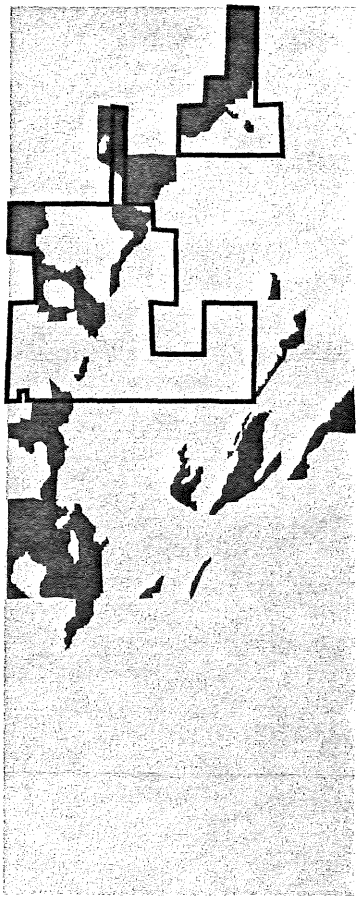


Figure 10: Wet prairie shown in dark gray (MN DNR, CD-ROM, 1997)

4. Calcareous Seepage Fens

Calcareous seepage fens are very rare communities. Fewer than 200 are estimated to exist in the 10 states where they have been reported (NatureServe, 2001). Two types are recognized in Minnesota: the boreal and prairie subtypes. The fens at Felton fall under the prairie subtype. They are characterized by the upwelling of alkaline groundwater, low dissolved oxygen, an accumulation of peat, and several rare plants adapted to the cool, calcium rich environment. Sterile sedge (Carex sterilis), whorled nut-rush (Scleria verticillata) are state threatened plants found in the fens, while hair-like beak rush (Rynchospora capillacea) is a plant of state special concern. In this case the whole complex is much more significant than the rare species it supports. Some scientists believe that the fens are remnants of the ice mass retreat 8,000 years ago (Tufford, 2001). The study area has two fens, one north and a larger 15 acre fen to the south (Fig. 11).

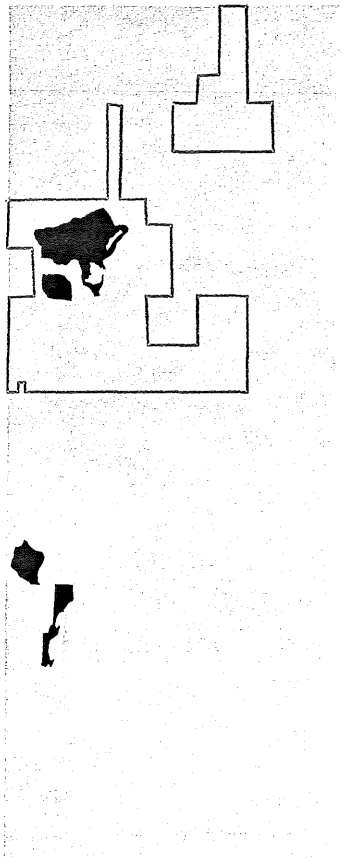


Figure 11: Fens shown in white, shrub swamp in dark gray (MN DNR, CD-ROM, 1997)

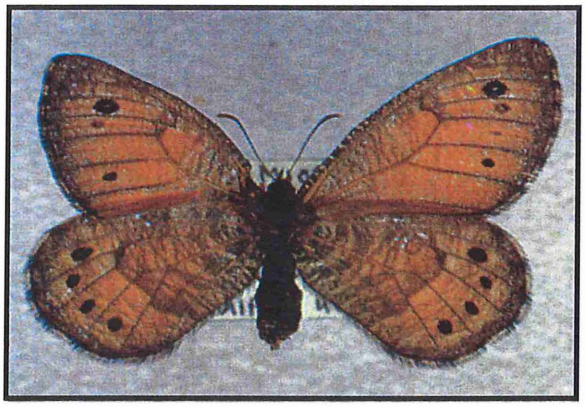
5. Shrub Swamp

This community is found at the base of beach ridges where it grades into the ancient lake bed. Usually groundwater seeps provide the hydrology to these systems. Willows dominate the vegetation matrix but other shrubs such as redosier dogwood and alder may also be present. Grasses and sedges also occur in this community but in poorly defined patches. In the study area, this community may have expanded in the absence of fire. Frequently it is found downslope of a seepage zone like calcareous fens (Fig. 11).

B. RARE SPECIES INVENTORY

Adapted to these different plant communities and utilizing various habitats are the following species. The species listed here are those classified as endangered or threatened at either the state or federal level, and species of concern listed at the state level.

1. Butterflies:



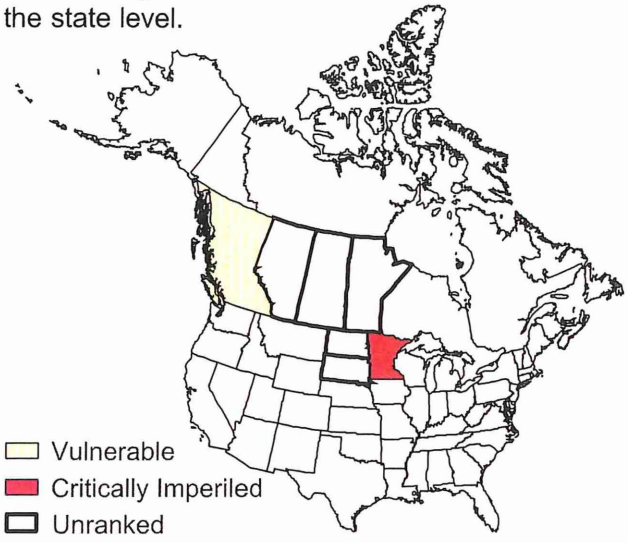
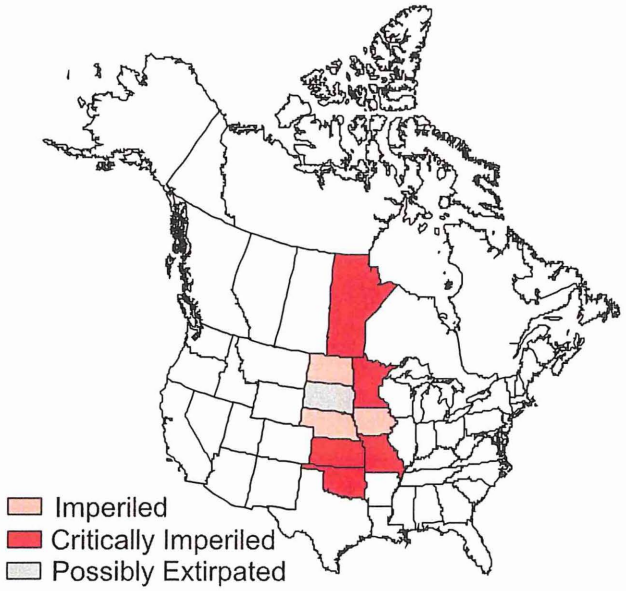


Figure 12: Photograph of Uhler's Arctic (MN DNR) and distribution map (NatureServe, modified per communication with Robert Dana, DNR)

Uhler's arctic (Oeneis uhleri varuna) is a state endangered species adapted to dry prairie. Very little is known about the life cycle of this species. The adults fly and breed in late spring (late May to early June) and the larvae likely feed on grasses and sedges (MN DNR, 1985). Minnesota is the only state with documentation of the species and Felton Prairie is the only documented population in the state. The remainder of its documented range is in Canada (NatureServe, 2001).



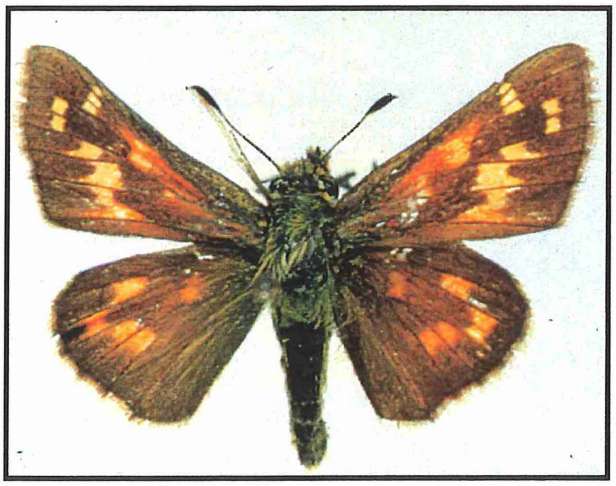


Figure 13: Photograph (MN DNR) and distribution map (NatureServe) of Assiniboia skipper

Assiniboia skipper (Hesperia comma assiniboia) is also on the state endangered species list. The adults fly and breed in late summer (mid August to early September) and they hibernate in an early larval or pupae stage. They also feed on grasses and possibly sedges but appear to prefer very dry sites (NatureServe, 2001).

Figure 14: Photograph (MN DNR) and distribution map (NatureServe) of Dakota skipper

Dakota skipper (Hesperia dacotae) is a threatened species in the state of Minnesota. Its life cycle has been documented by Dr. Robert Dana of DNR. The adults fly and breed in early summer (mid June to early July) and eggs are laid at the base of grasses and forbs. Once hatched the larvae construct a concealed shelter of silk just below the soil surface. They forage mainly at night, dragging blades of grass back into their shelter for consumption. During the larval and pupae stages, Dakota skippers are nearly impossible to locate (Dana, 1991). They depend on dry to dry-mesic prairie.

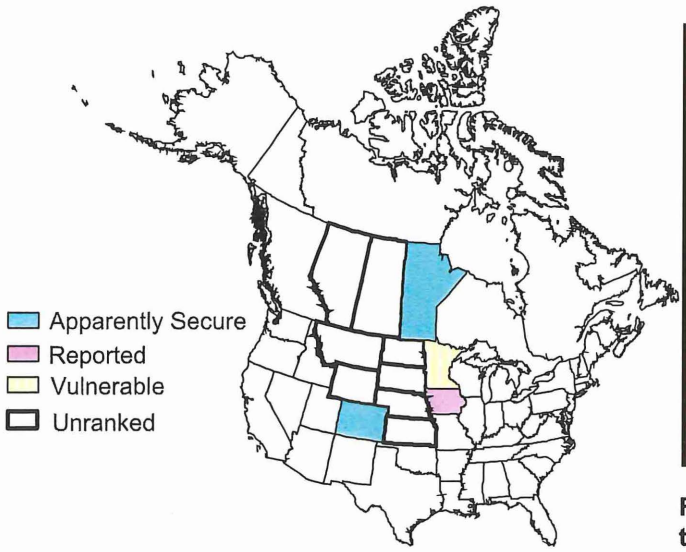


Figure 15: photograph (MN DNR) and distribution map (NatureServe) of Pawnee skipper.

Pawnee skipper (Hesperia leonardus pawnee) is state listed as a species of special concern. Minnesota appears to be the eastern edge of its range according to current taxonomy. It is adapted to dry and dry-mesic prairie (NatureServe, 2001).

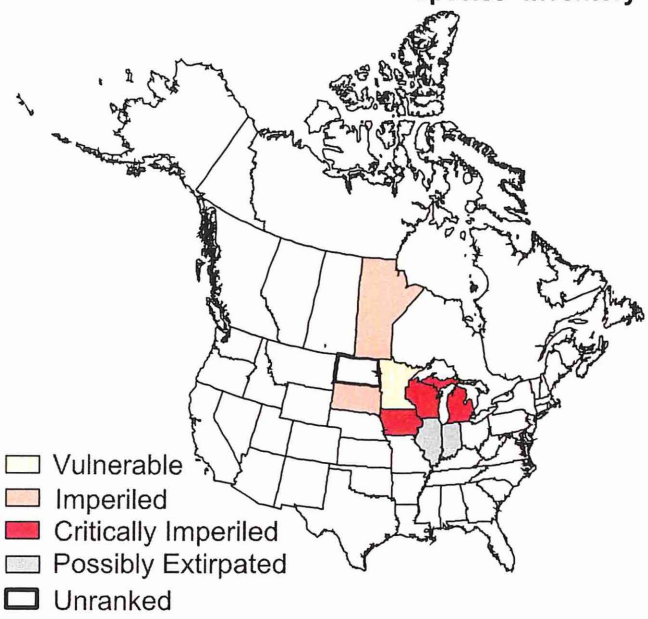


Figure 16: Photograph (MN DNR) and distribution map (NatureServe) of Powesheik skipperling.

Powesheik skipperling (Oarisma powesheik) is state listed as a species of special concern. Elsewhere it may be extirpated (Illinois, Indiana), critically imperiled (Michigan, Wisconsin, Iowa), imperiled (South Dakota), or unranked (North Dakota). It prefers dry to dry-mesic prairie although in the eastern U.S. will utilize fens. Populations of this species are isolated due to habitat loss and possibly prescribed burning. "In general it is doubtful that any managed area where the fire return interval is less than four years per unit, or any area burned as one unit, should be considered protected," (NatureServe, 2001). This species is affected by burning because all stages of the life cycle are spent above ground.

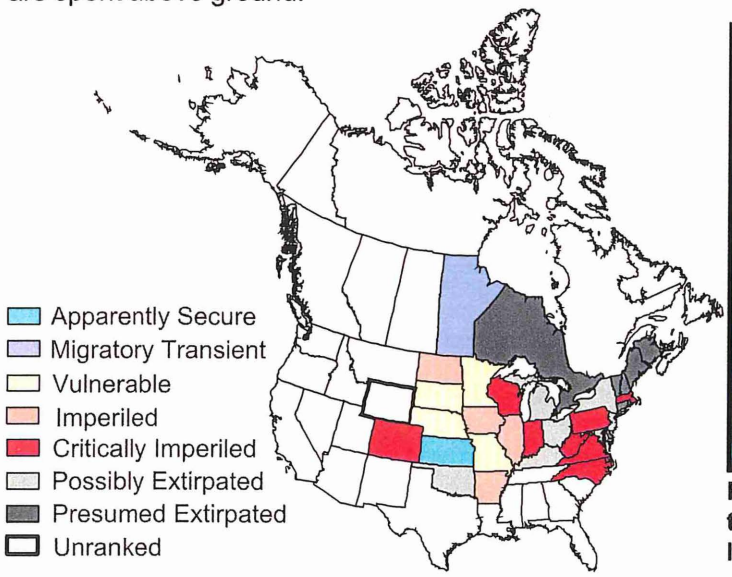


Figure 17: Photograph (MN DNR) and distribution map (NatureServe) of regal fritillary.

Regal fritillary (Speyeria idalia) is state listed as a species of special concern. It is adapted to dry and mesic prairie. It formerly ranged across much of the eastern US but its habitat is highly fragmented and declining rapidly east of the Mississippi River. Isolated populations are vulnerable to natural disturbances like drought and human impacts including agricultural chemicals, habitat conversion and prescribed burning. "While the species is still extant in many prairie remnants, it does appear to be excluded or threatened in some remnants by excessive prescribed burning and to be held at low numbers at many or most occurrences by rotational burning," (NatureServe, 2001).

2. Birds:

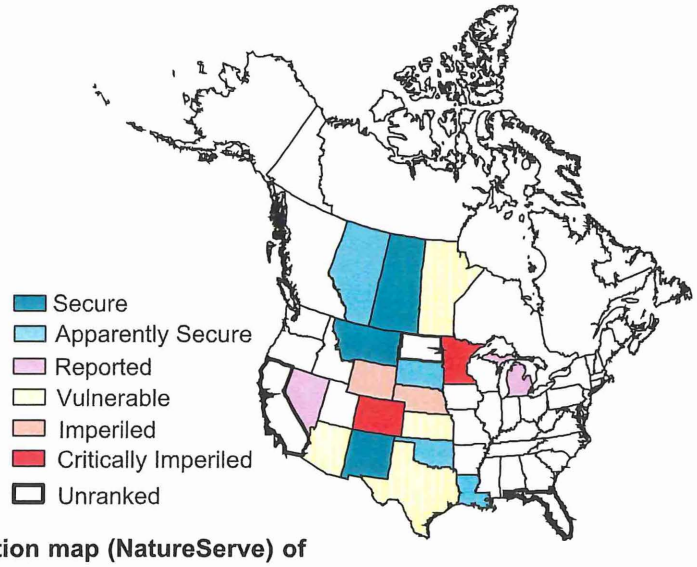


Figure 18: Photograph (MN DNR) and distribution map (NatureServe) of chestnut-collared logspur.

Chestnut-collared longspur (Calcarius ornatus) is endangered in the state. Breeding takes place in Minnesota. The species prefers native prairies that are moderately grazed or mowed. It prefers vegetation in the 20-30 cm range (NatureServe, 2001). Longspurs have been observed north of the county gravel pit and utilize the area for feeding if not nesting.

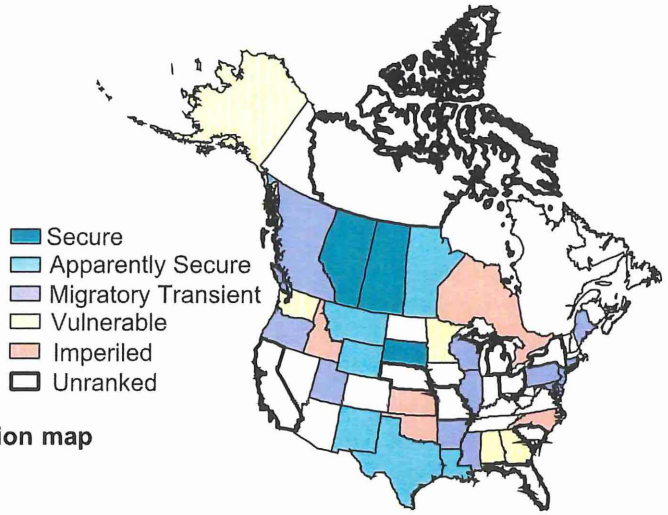


Figure 19: Photograph (MN DNR) and distribution map (NatureServe) of marbled godwit.

Marbled godwit (Limosa fedoa) is listed as a species of special concern in Minnesota. The largest breeding populations are found in the prairies of the upper Midwest and Canada near wetlands. "Keys to management include providing short, sparse to moderately vegetated landscapes that include native grasslands and wetland complexes. Wetland complexes contain a diversity of wetland classes, including ephemeral, temporary, seasonal, semi-permanent, and permanent wetlands, as well as intermittent streams," (NatureServe, 2001). Godwits have been observed throughout the study area.

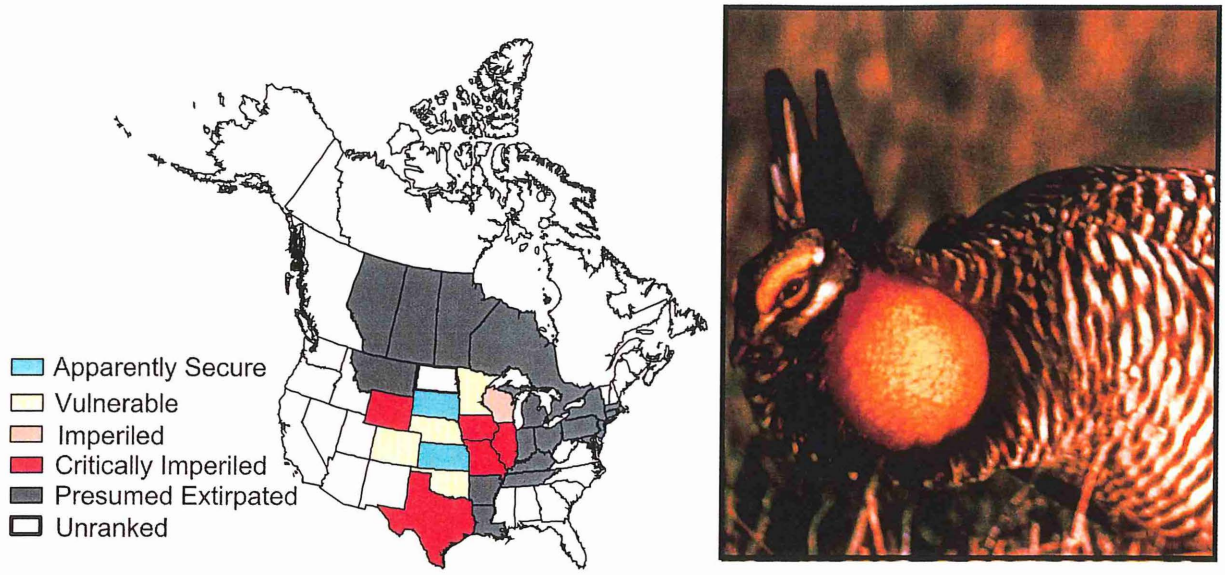


Figure 20: Photograph (MN DNR) and distribution map (NatureServe) of the greater prairie chicken.

Greater prairie chicken (Tympanuchus cupido) is listed as a species of special concern in the state. These birds nest and forage in prairies and occasionally cultivated fields in close proximity to native grassland. Scientists have identified numerous prairie chicken booming grounds in the study area.

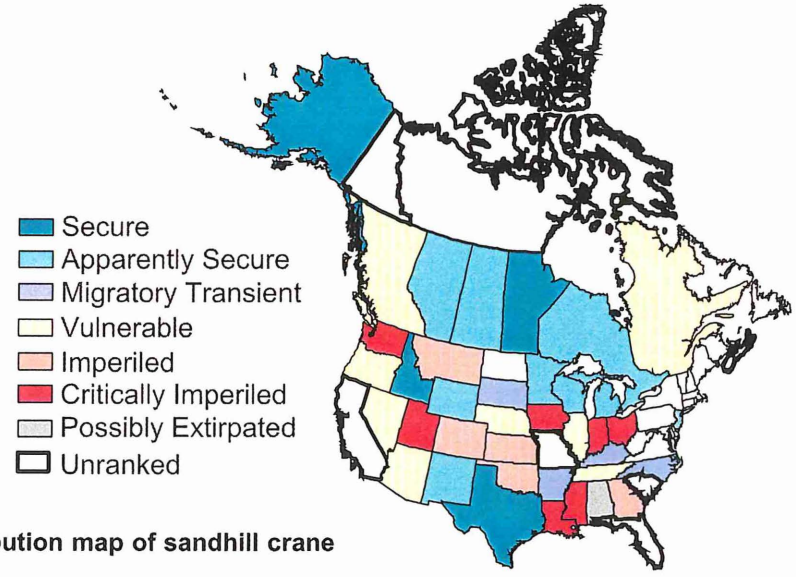


Figure 21: Distribution map of sandhill crane (NatureServe).

Sandhill Crane, a species of special concern, uses the area during migration periods (NatureServe, 2001).

3. Small Mammals:

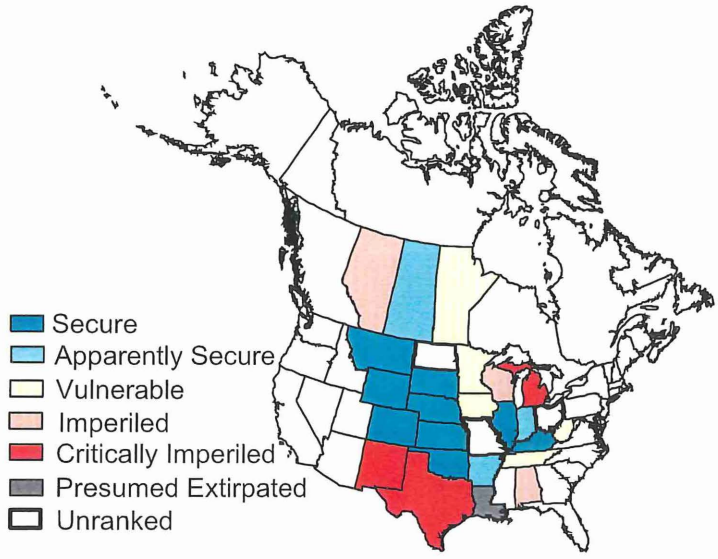


Figure 22: Distribution map of prairie vole (NatureServe)

Prairie vole (Microtus ochrogaster) is a state listed species of special concern and depends on dry prairie habitat. Felton Prairie has the state's best prairie vole population and the one most likely to persist barring any future habitat disturbance.

4. Reptiles:

Western hognose snake (Heterodon nasicus) is state listed as a species of special concern. It prefers sand or gravel prairies and hibernates by burrowing into the ground. Females lay eggs in nests a few inches below the surface (NatureServe, 2001).

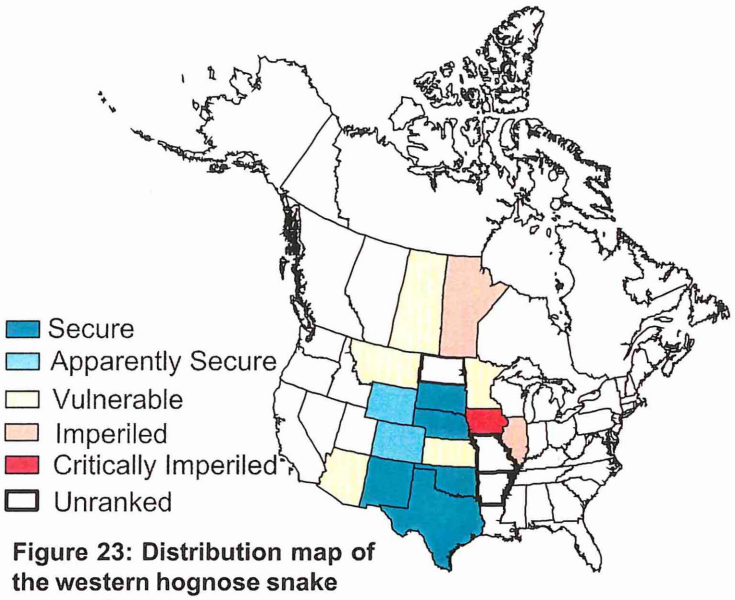


Figure 23: Distribution map of the western hognose snake (NatureServe)

5. Rare Plants:

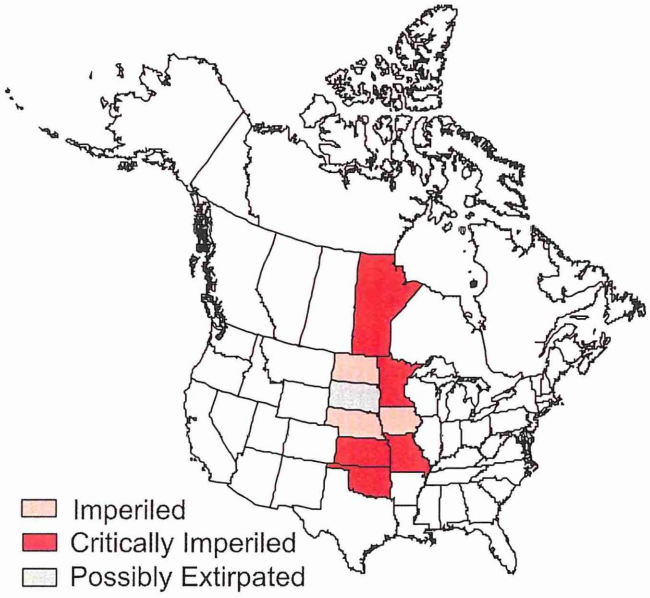


Figure 24: Photograph (MN DNR) and distribution map (NatureServe) of the western prairie fringed orchid

Western prairie fringed orchid (Plantathera praeclara) is a federally listed threatened species found in mesic to wet prairies. It is known to occur on Bicentennial Prairie SNA and has been documented elsewhere in the Felton area.

Other plants are described under community types, pages 13-14.

Species Inventory

Felton Prairie is best known to the general public for the numbers and variety of rare birds found in the area. It is the best place in Minnesota to catch a glimpse of the chestnut-collared longspur along with other prairie species including Sprague's pipit. The area is also featured in the Detroit Lakes Birding Festival held every year in June. Visitation rates to the area are difficult to monitor and estimate, but anecdotally, Felton Prairie is an important site on the national level. *Audubon* Magazine, *Minnesota Birding*, and the recently published *Birding the Fargo-Moorhead Area* have all highlighted the area. Additionally, many people from the Fargo-Moorhead Area visit Felton along with Bluestem Prairie near Hawley, MN to see native prairie and experience a landscape similar to that seen by early settlers of the region.

C. Fragmentation

A quick glance at Figure 25 reveals gaps in the linear ribbons of prairie types running north to south with a slight east to west tilt. One of the most prominent gaps is Section 1 in Flowing Township, also known as the Zillmer site. This section has some wet prairie (11 acres) but the southeast corner disrupts the continuum of dry and mesic prairie from the county land to native grasslands south of the study area. The landscape topography may have been altered by mining activity in the 1960's to such a degree that it cannot support dry prairie, however, mesic prairie could be restored there.

The most critical link in the study area connects habitat north of the county pit with the Bicentennial Prairie SNA. This corridor narrows down to 100' between the county pit and the aggregate mining site northeast of it, but its existence is critical to preventing further fragmentation and loss of Dakota skipper habitat among others. Note the clustering and concentration of species north of county pit, along the isthmus between the pits, and on Bicentennial Prairie seen in Figure 33. In general, the greatest concentration of species occurs on mesic and dry prairie. Although it is private land, the agricultural and mined quarter section (NW 1/4, Section 5 Keene) northeast of the county pit also creates a gap in the habitat that could be addressed when mining operations conclude. If the mined area were restored to mesic prairie, then another corridor would exist between county land north of the pit and Bicentennial Prairie SNA. This corridor would be strengthened further by integrating the southern portion of the State Trust Fund land. The goal of achieving prairie preservation with aggregate mining may be accomplished by ensuring the gravel pits are islands of disturbance in a matrix of prairie habitat rather than the prairie existing as islands in a mined landscape. This way corridors and links will maintain the functionality of habitats and allow dispersion along the ridges and swales.

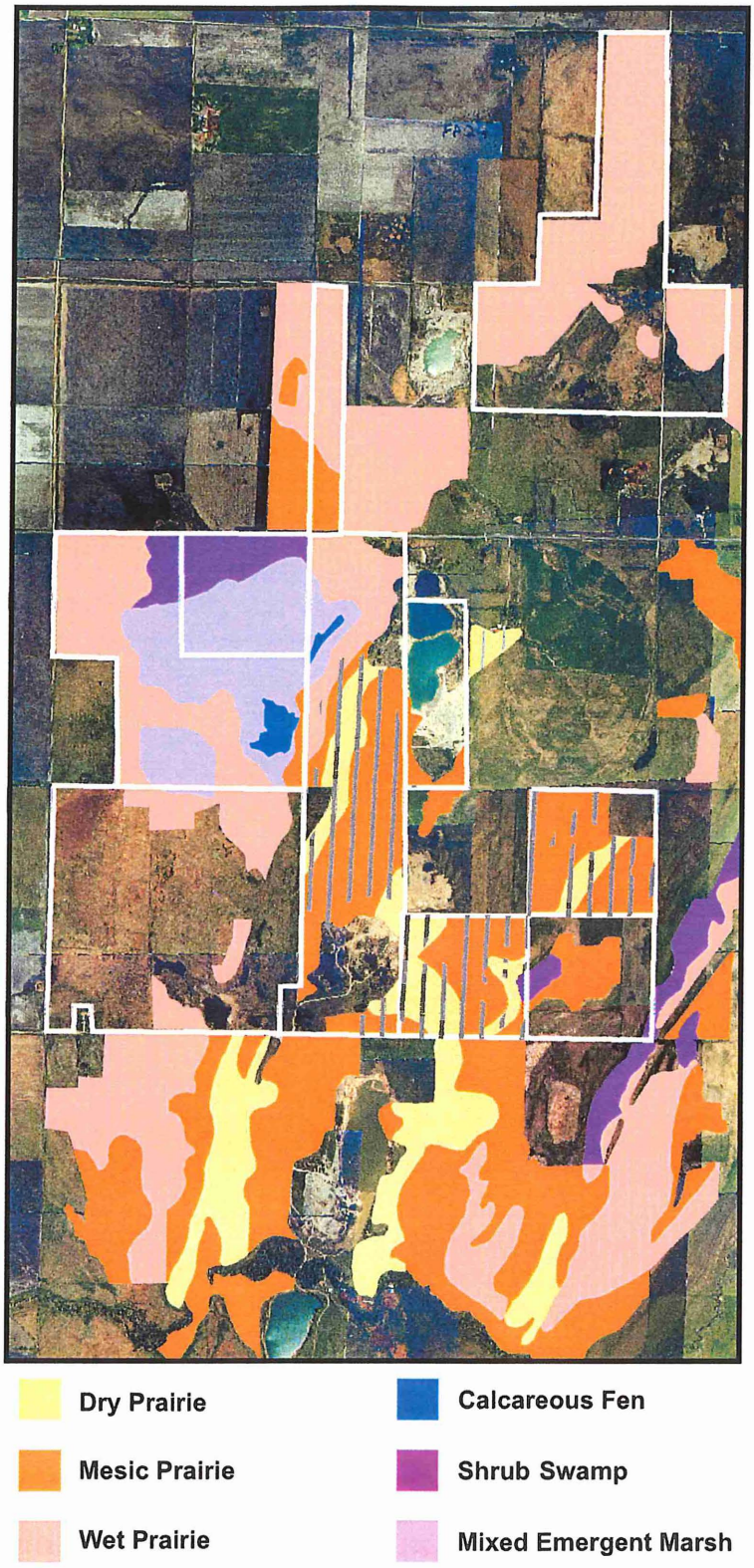


Figure 25: Note gaps in habitat type and coverage, gray stripes indicate Dakota skipper habitat.

D. Calcareous Fen Study

Under the regulatory authority vested in DNR under Minnesota Statute 103G.233, any activity that has the potential to drain, fill, alter, or otherwise degrade a calcareous fen, either directly or indirectly, requires a DNR approved fen management plan. In order to determine the impacts of gravel mining on the local fens, DNR Division of Water installed a number of groundwater monitoring wells and began collecting data from them in the late 1990's. Assessing impacts of aggregate mining on the fens poses a number of difficulties. First, the fens are dependent on ground water flows that cannot be seen. Ground water can be monitored by drilling wells and measuring water levels at regular intervals, but this is point data. Activity between the wells is interpolated but cannot be verified without drilling more wells. Even with many data collection points, accuracy in the prediction of ground water elevations and flow patterns will be limited to the number of years data have been collected. This situation is similar to the availability of data for climate and flood prediction: hydrologists usually have records covering 100 years of precipitation and stream flow but still cannot predict what will happen in the future. The ability to improve prediction increases with the length of record-keeping. Limited data are available from a short period of time for the analysis of groundwater flows to the fens in the study area.

Geologists have determined the current groundwater elevation. Like the land above it, the groundwater slopes from east to west with a slight northeast to southwest tilt. Figure 26 shows the groundwater contours as measured by DNR. Notice that a ridge has formed south of the School Trust Fund mine and another north of the Zillmer pond. Open bodies of water allow for accelerated loss of moisture through evaporation. This condition draws soil moisture along with groundwater toward the open body of water. In order to protect the fens and compensate for limited data, DNR has established a 10' buffer elevation above the groundwater contours. This will compensate for seasonal and annual fluctuations in groundwater which is fed by annual precipitation. The impact of these findings on mining will be explored in the Aggregate Resources section of this report (pages 32-33).

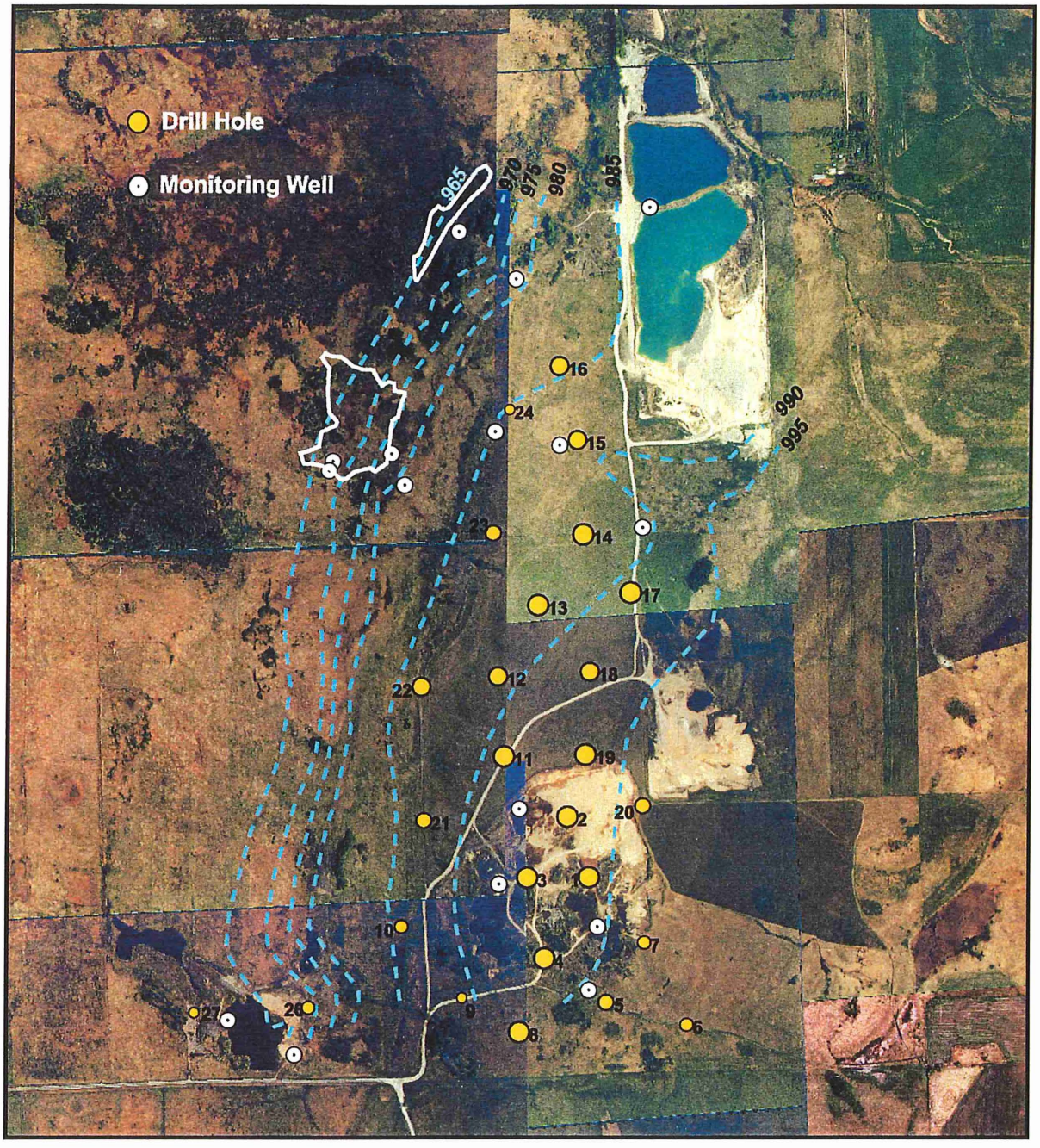


Figure 26: Blue contours represent the water table slope. Fens are outlined in white, white dots mark the location of groundwater monitoring wells and yellow dots mark rotosonic drill holes.

IV. AGGREGATE RESOURCE CONSIDERATIONS

A. Regional Consumption

The United States Geological Survey (USGS) rates aggregate quality and availability nationwide. Clay County is located in the Western Lakes and Lacustrine Plains section and has an availability rating of "limited to problem:"

> "The major type of aggregate is sand-gravel of glacial origin. Crushed stone sources are limited...large areas are completely void of aggregates; viz., large old glacial lakebeds. Sand-gravels, where available, frequently are contaminated by sandstone and shale particles from the dominant regional bedrock." (USGS, 2001)

Generally speaking, the Red River Valley is an aggregate poor region. Bedrock is buried beneath 200-400' of glacial and lacustrine deposits. The best source of gravel is the Agassiz beach ridges. On the North Dakota side of the valley, most of the beach ridge material is sand and the quality is lower than that found on the Minnesota side. The haul distance from North Dakota sources for high quality gravel to Fargo-Moorhead is also greater than from Clay County deposits.

B. Clay and Cass County Consumption

Aggregate provides the foundation for all infrastructure and development in Fargo-Moorhead, the primary market for aggregate resources in Clay County. The region grew 14% from 1990 to 2000 and is projected to grow another 4% by 2010 (see Table 2). The sand and gravel industry estimates U.S. consumption to equal 10 tons per person per year. Consumption in the Red River Valley will exceed that because local soils are poorly drained and have low strength or bearing capacity. The use per person in this region is approximately 13 tons per year (Squires, 2001). USGS estimates that nationally the amount of aggregate needed over the next 25 years will equal all of the material mined in the twentieth century. Sand and gravel use is projected to increase 0.5% annually nationwide and will probably exceed this rate in Fargo-Moorhead because crushed stone is not economically available to the market at this time.

	POPULATION			AGGREGATE USE
YEAR	CLAY COUNTY	CASS COUNTY	TOTAL	Yards/year
1990	50,422	102,874	153,296	1,423,463
2000	51,229	123,138	174,367	1,619,122
2010	54,850	127,259	182,109	1,691,012

Table 2: Population (US Census Bureau, 2000) and estimated aggregate consumption based on a consumption rate of 13 tons per person per year.

DNR mapped aggregate potential for Clay County in 1996 (MN DNR, Aggregate Resources, 1997) and found that the eastern part of the county where the beach ridges are located has the greatest potential for aggregate. The report specifically cited the area near Felton as having one of the best and largest sources of concrete aggregate in the Red River Valley. Currently Clay County has approximately 70 permitted mining operations. Nearly all of these mine gravel from the beach ridges. The county's gravel pit seen in Area 1A, Figure 27, supplies 6% of the total aggregate used in Clay County.

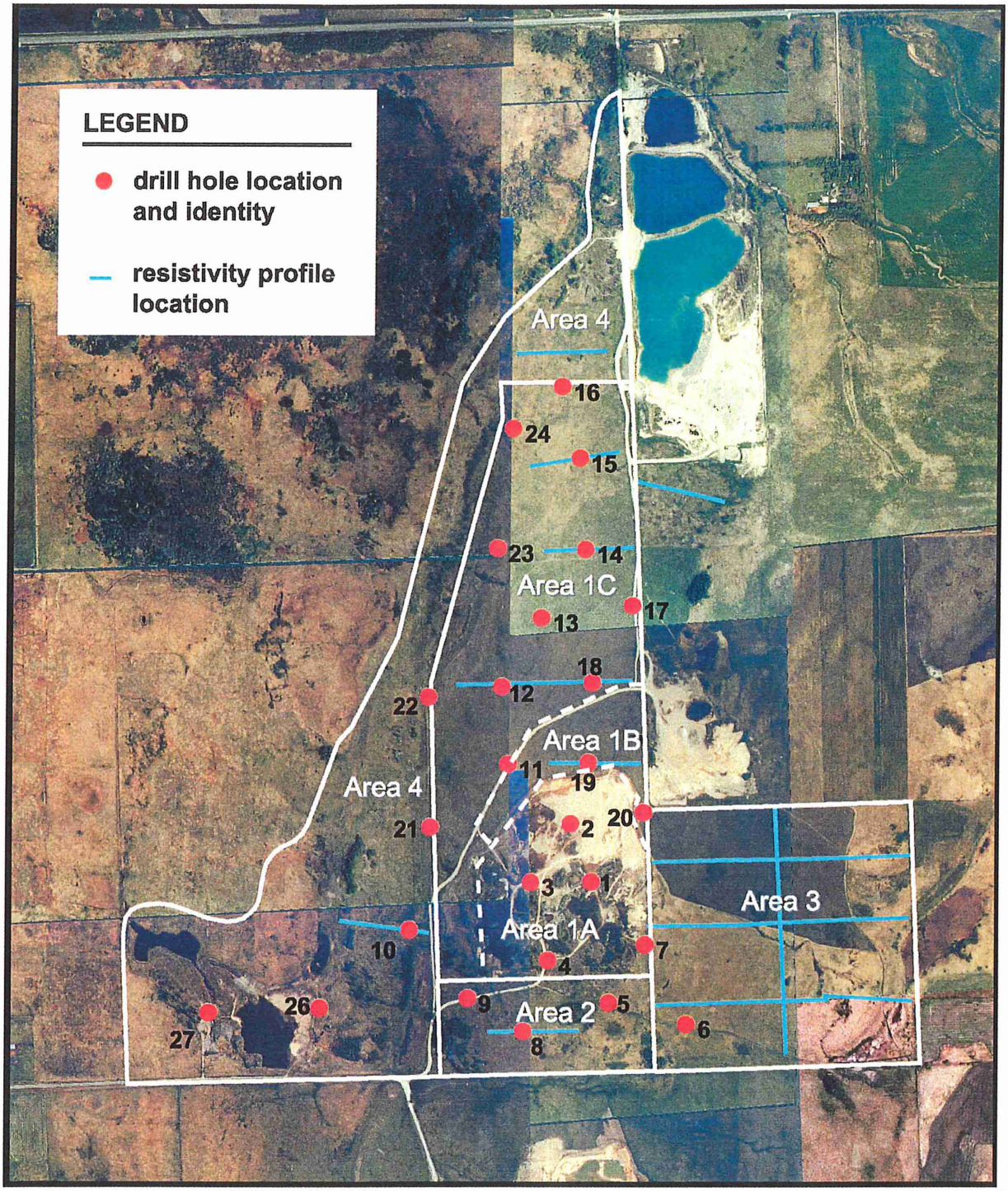


Figure 27: Location of rotosonic drill holes in red, resistivity profiles in blue, and identification of areas analyzed by the Aggregate Resource Evaluation (MN DNR, 2000).

C. Felton Prairie Aggregate Resources

1. Summary of the Felton Prairie Aggregate Resource Evaluation

In 1999 DNR conducted an aggregate resource evaluation on 735 acres of county and state owned land within the Felton Prairie study area. The purpose of the aggregate evaluation was to obtain more information on the quantity and quality of aggregate in those selected areas. The area to be evaluated was divided into four smaller areas (Fig. 27):

Area 1: Clay County gravel pit and county land north of it
Area 2: South of the Clay County gravel pit
Area 3: Bicentennial Prairie SNA
Area 4: West of active gravel pits and Area 1

Data collected from nine electrical resistivity transects was used to target potential drill hole locations. Then a rotosonic drilling rig was used to collect core samples from 27 drill holes (Fig. 27) ranging from 25 to 145 feet deep. Core samples were retained and later sampled for quality analysis by the Minnesota Department of Transportation. Aggregate volumes for some areas were estimated using a computer model. Drill hole locations, drill logs, quality analysis, and volumes were summarized in the Aggregate Resource Evaluation (DNR, 2000) delivered to the Felton Prairie Stewardship Committee in May, 2000. The committee used the aggregate evaluation data as the basis for further interpretation on following pages.

In addition to collecting core samples, investigators estimated an approximate water table elevation at each drill hole. This information was used by scientists from the DNR Division of Waters who analyzed the hydro-geologic conditions supporting the calcareous fens west of the drilling sites in the study area (Fig. 26).

The aggregate resource evaluation identified two deposits: a deep primary deposit of high quality material and a shallow secondary deposit of discontinuous beach ridges. The primary deposit reaches a depth of 100' east of the Clay County gravel pit. The overburden material ranges from medium sand to silts and clay. The volume and quality for each area is summarized below and in table 3:

Area 1: This area (Fig. 27) is estimated to have 24 million cubic yards of sand and gravel and contains the primary deposit. The evaluation further subdivided this area into A (county pit), B (north of the county pit), and C (remainder).

A- 5.9 million cubic yards: nearly all of the material above the water table in the county pit has been mined. What remains will require methods and equipment suitable for working below the water table.

B- 2.9 million cubic yards, 0.9 million cubic yards above the water table, 2 million cubic yards below: overburden thickness is 2' or less making it cost effective to mine. The deposit thickness ranges from 68-93' and the quality of the upper portion is very good and meets concrete specifications. The lower portion has some shale mixed in with sand.

C- 15.3 million cubic yards, 3.4 million above the water table and 11.9 million below: overburden ranges from 10-20'. The deposit thickness ranges from 0-83' with good quality above the water and shale mixed with sand below the water.

Area 2: Not enough core samples were drilled in this area to estimate the quantity of the deposit. What was drilled had deep overburden ranging from 29-55'. The deposit quality is good, however, and ranges from 0-57' thick.

Area 3: No quantity was calculated for this area because the singular drill sample contained no aggregate. The resistivity profiles north of this drill hole (#7) indicated significant gravel and led to additional profiles taken in August 2000 which showed that 40 acres in the northwest portion has high gravel potential. Thirty acres in the southwest corner also

showed significant aggregate but excessive overburden for the current market. The remaining 90 acres were silt and sand (MN DNR, 2000). No volumes were calculated for this area.

Area 4: Deposit is surficial, irregular and poorly graded.

AREA	1A	1B	1C	2	3	4
Over-burden	0	<2'	10-20'	29-55'	NA	0-9'
Aggregate thickness	55-65'	68-93'	0-83'	0-57'	0-100+'	<10'
Total Volume (cy)	5,900,000	2,900,000	15,300,000	NA	NA	NA
Notes	good quality	good quality	good quality	good quality	No sample	Uneven quality

Table 3: Table summarizes DNR interpretation of the data by area. Volume shown in cubic yards.

Table 4 lists the analysis of core samples taken from each drill hole. These data include the depth of overburden, depth of aggregate, and additional interpretation developed by the stewardship committee. This interpretation includes an aggregate to overburden ratio derived by dividing the depth of the aggregate by the depth of overburden. The ratio value represents the depth of aggregate per foot of overburden. This is mapped in Figure 29. Under current market conditions, operators typically need a resource depth of 10' and a ratio of 10 or better to mine profitably. The drill hole symbols in Figure 29 represent the quality of the material sampled from that location. Members of the stewardship committee representing the gravel industry analyzed the sample data for each of the drill holes and rated them for quality on a scale of 1 to 10, 1 being poor and 10 being good. Their evaluation was based on the percentage passing sieve # 4 and is shown in column 5 of Table 4. That value was then used as a multiplier (10=1, 5=0.5) to obtain a singular value for quality and quantity comparison. It is important to note that these values were developed by the stewardship committee for mapping and comparison purposes only and do not convey commercial value or scientific accuracy.

Drill Hole #	Deposit Thickness	Overburden	Gravel to Over-burden Ratio (1)	Quality Rating (2)	Ratio x Quality Coefficient (3)
1	55	0	55.0	9	49.50
2	54	0	54.0	9	48.60
3	65	0	65.0	10	65.00
4	63	2	31.5	10	31.50
5	57	29	2.0	6	1.18
6	0	55	0.0	2	0.00
7	103	2	51.5	3	15.45
8	54	47	1.2	10	1.15
9	0	55	0.0	0	0.00
10	9	7	1.3	2	0.26
11	68	2	34.0	10	34.00
12	61	15	4.1	7	2.85
13	83	2	41.5	9	37.35
14	77	1	77.0	10	77.00
15	72	19	3.8	8	3.03
16	45	20	2.3	8	1.80
17	64	19	3.4	10	3.37
18	82	2	41.0	8	32.80
19	77	2	38.5	9	34.65
20	93	2	46.5	6	27.90
21	16	1	16.0	5	8.00
22	11	2	5.5	7	3.85
23	42	10	4.2	5	2.10
24	0	65	0.0	0	0.00
25	1	5	5.0	2	1.00
26	6	9	0.7	3	0.20
27	0	40	0.0	0	0.00

Table 4: Drill hole data for rotosonic drill core samples
(1) Gravel to overburden ratio derived by dividing the aggregate depth by overburden. Value listed equals the number of feet of aggregate per foot of overburden.
(2) Committee's quality rating is based on the percentage of material passing a #4 screen. 10 = <50%, 9 = 55-60%, 8 = 60-65%, 7 = 65-70%, 6 = 70-75%, 5 = 75-80%, and others as deemed appropriate.
(3) This value represents the relative value of the deposit samples. The quality rating (2) is used as a multiplier e.g. 10 = 1.0, 8 = 0.8, etc. for the overburden ratio.

2. Resistivity Study of Bicentennial Prairie

At the request of the committee, DNR completed additional resistivity profiles along transects in Bicentennial Prairie shown in Figure 27. These were taken because core samples from drill hole numbers 7 and 20 showed significant aggregate and low overburden. This additional evaluation indicated a significant sand and gravel deposit; however, the deposit quality and ratio of sand to larger particles cannot be determined without local rotosonic drilling. The study suggests a significant deposit on the west side of Bicentenial Prairie with little overburden in the north but increasing in depth to the south. The study concludes that the northwest 40 acres has high aggregate potential with little overburden (MN DNR, 2000). The stewardship committee's contours in Figure 28 also indicate increasing overburden to the south.

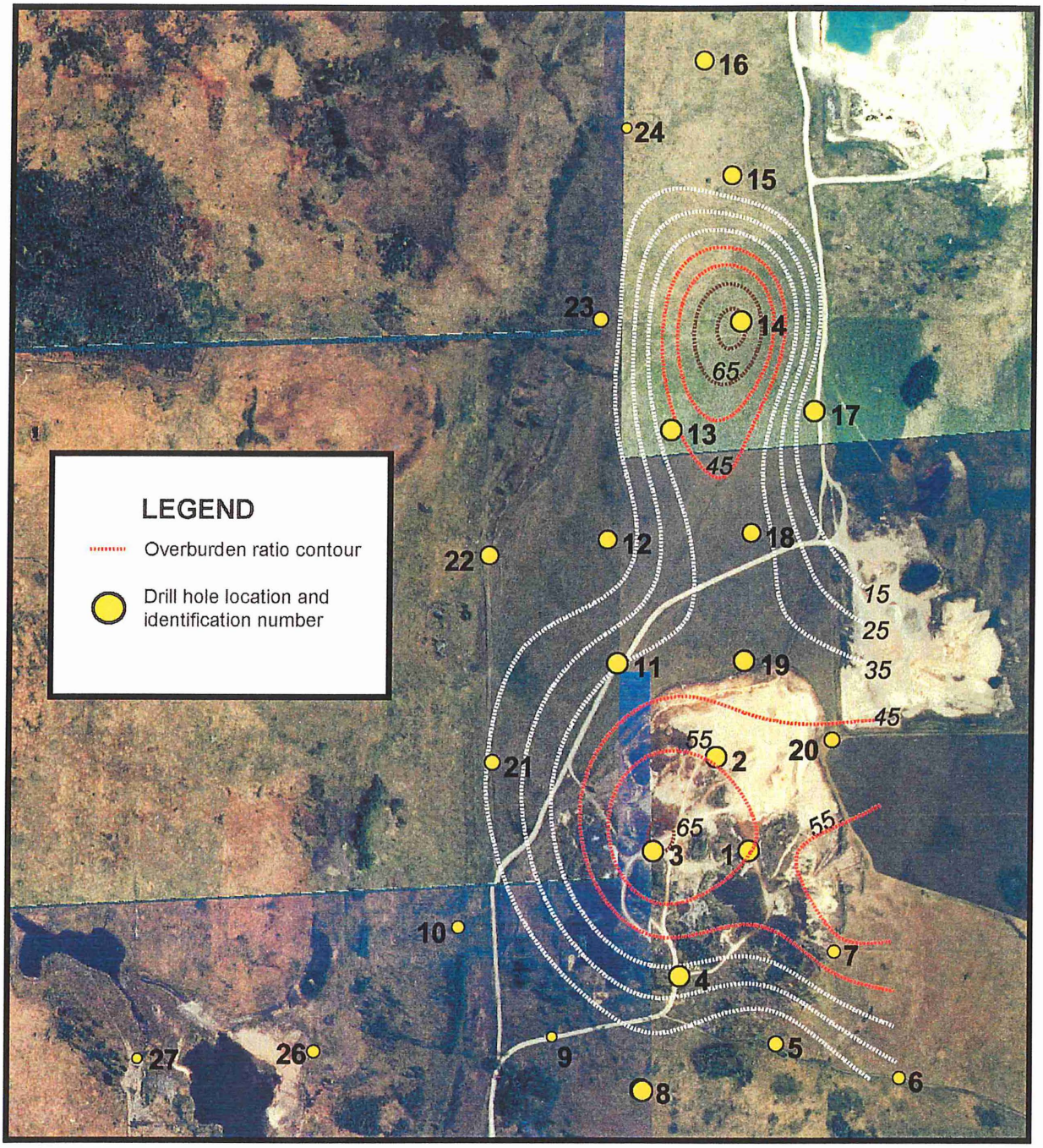


Figure 28: Contours representing the desirability (aggregate:overburden ratio) of the aggregate resources on Clay County property.

Fen Protection Impacts

3. Impacts of Fen Study on Gravel Mining in the Study Area

In addition to mapping groundwater as seen in Figure 26, DNR scientists also responded to questions posed by the committee regarding sensitive areas where the 10' buffer elevation would be in effect. The following points summarize their recommendations:

1. State School Trust Fund Pit
 • Extending the Trust Fund pit south (mining below the water table) will result in further degradation to the north fen, and possibly begin to impact the south fen.
2. County Mine
 • Extending the county pit north (mining below the water table) will result in alteration of the hydrology of the south fen. The farther north the county mines, the greater the impact.
 • Extending the county pit south or west (mining below the water table) is not likely to affect the hydrology of the south fen, however additional monitoring wells should be established to verify this.
3. Private mine, Section 5, Keene Township
 • Mining below the water table in the private pit will result in alteration of the hydrology of the south fen. However, this pit is scheduled to close in fall 2001 and will be reclaimed.

Dry mining above the water table north of the county pit, and south of the Trust Fund pit, and on the private land will not initially affect the hydrology of the fens. However the closer the excavation gets to the water table, the greater the likelihood that some impact will occur.

Given these limitations the committee developed a table and graphic representation of the impact fen protection will have on aggregate availability for each of the core samples evaluated by the Minnesota DNR Division of Resources in 1999. The overall resource evaluation will be explained in more detail in the next section (IV), but it should be noted that a 10' buffer elevation reduces the accessible or mineable aggregate to 11% of the deposit north (#11-27) of the current county mine.

Drill Hole ID	Surface Elevation	Gravel Thickness	Depth of Overburden	Gravel from Elevation	Gravel to Elevation	WT Elev.	10' Fen Buffer Elev.	Gravel above 10' Buffer
1	1004.660	55	0	1004.66	949.66	994.40	1004.40	0.26
2	1004.082	54	0	1004.08	950.08	993.40	1003.40	0.68
3	1005.096	65	0	1005.10	940.10	992.20	1002.20	2.90
4	1007.849	63	2	1005.85	942.85	993.10	1003.10	2.75
5	1033.482	57	29	1004.48	947.48			
6	1041.818	0	55	1041.82	1041.82			
7	1048.130	103	2	1046.13	943.13			
8	1016.254	54	47	969.25	915.25			
9	1012.812	0	55	1012.81	1012.81			
10	998.334	9	7	991.33	982.33			
11	1012.009	68	2	1010.01	942.01	990.80	1000.80	9.21
12	1008.206	61	15	993.21	932.21	989.00	999.00	-5.79
13	1009.650	83	2	1007.65	924.65	988.60	998.60	9.05
14	1017.622	77	1	1016.62	939.62	988.30	998.30	18.32
15	1012.914	72	19	993.91	921.91	988.50	998.50	-4.59
16	1010.578	45	20	990.58	945.58	984.50	994.50	-3.92
17	1020.056	64	19	1001.06	937.06	990.90	1000.90	0.16
18	1017.192	82	2	1015.19	933.19	991.30	1001.30	13.89
19	1022.435	77	2	1020.43	943.43	993.40	1003.40	17.03
20	1041.277	93	2	1039.28	946.28			
21	1006.248	16	1	1005.25	989.25	987.00	997.00	8.25
22	1003.833	11	2	1001.83	990.83	986.00	996.00	5.83
23	1008.009	42	10	998.01	956.01	986.00	996.00	2.01
24	1003.364	0	65	1003.36	1003.36			
26	989.548	6	9	980.55	974.55			
27	966.255	0	40	966.26	966.26			
North of Cty Mine		797	feet					83.75
Percent Available								11

Table 5: Impact of fen protection on aggregate resource availablility. Drill holes #1-4 are in the current county mine footprint and will be mined below the water table (wt).

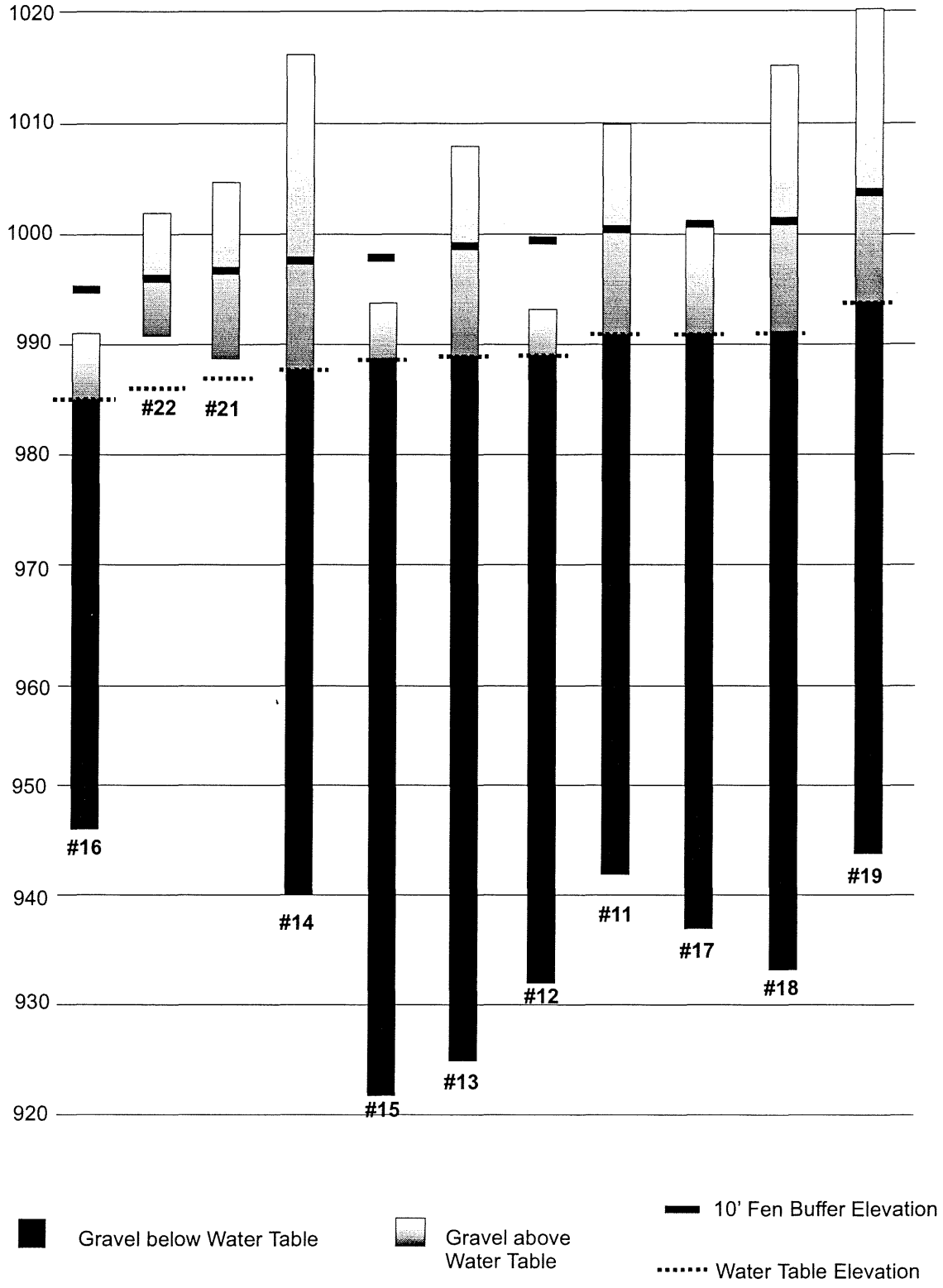


Figure 29: Illustrates the relative quantity of aggregate found in drill holes above and below the water table and fen buffer elevation. Only those drill holes affected by the 10' buffer are shown and are arranged in ascending water table elevation.

4. General Assessment of Aggregate Resource

Based on the results of the rotosonic drill study, high quality aggregate is available within the existing footprint of the Clay County gravel pit and north of it towards the School Trust Fund pit. Additional drilling would be needed to better estimate the quality and quantity of the aggregate resource in the northwest corner of Bicentennial Prairie SNA. With the exception of the School Trust Fund mine, most of the material found on state land is shallow, poorly sorted, and of lesser quality than that found on county land. For this reason and because of the environmental permitting requirements that will arise if the county chooses to continue surface mining north (see Alternative 3 of the mining scenarios), or below the fen buffer elevation, the stewardship committee assessed the county's mining options in greater detail (Section E, pp. 36-43).

D. Northern Clay County Aggregate Needs

According to the Aggregate Resource Evaluation (MN DNR, 2000), the primary aggregate deposit indicated by rotosonic drilling is found on county land within the current gravel pit and north. This deposit meets MnDOT specifications for concrete, but portions of it are buried under significant overburden, especially south of the current footprint. This poses an economic barrier to extraction under current market conditions; however, it may become cost effective to mine this material in the future as other surface supplies in the region are depleted. This high quality aggregate will likely maintain or increase its value over time. The report estimates 5.9 million cubic yards of gravel remains within the current footprint of the county gravel pit. Approximately 2.5 million yards of additional material may lie west and south of the current mined footprint. Not all of this can be mined since equipment cannot remove material at a 90 degree angle. The committee estimates an accessible volume of approximately 6.5 million yards within the current mine footprint, west and south. This could supply the county's road needs for a minimum of 65 years or longer depending on the amount of finer material (fines) that would be mixed with aggregate mined below the water table to meet Class 5 specifications. Class 5 aggregate (road gravel) is a mixture of gravel and fine particles an inch in diameter or less, with no more than 10% being very fine silt or clay. Processing the aggregate below the water table will require additional crushing and mixing to meet the Class 5 specification. The aggregate below the water table in the county pit will lack fine particles like clay that are needed to bind a road-quality mix together. For this reason the county will need to mix overburden and spoil found onsite if they are suitable or import fines to create a Class 5 mix for road gravel.

Each year the Clay County pit supplies approximately 60,000 cubic yards of road gravel (Class 5) for 200 miles of road maintenance under county control and 40,000 cubic yards for 400 miles of township road maintained by thirteen of the northern townships. The amount used by the county accounts for 40% of the county's annual aggregate purchase of 150,000 c.y. The townships that buy Class 5 from the county mine are identified in Figure 30. The county has mined gravel from the current site since the late 1940's. The current footprint of the mine is approximately 60 acres. Only gravel above the water table has been mined to date. When all of this material is removed, the method of extraction will change and costs will increase. Table 6 lists the townships that purchased Class 5 from the county in 2000 and estimates an average cost per yard. The county's cost per yard is given along with the estimated haul distance and cost. As can be observed in the table, hauling costs sometimes comprise the majority of the cost to a township and the county. Six out of the 13 pay more in hauling fees than for the gravel itself. Distance is a critical factor in the cost of aggregate and will be a concern for the county if fines need to be imported to the current mine for mixing Class 5 aggregate with material mined below the water table. If the townships purchased Class 5 from a private source, the cost will increase approximately 30% overall, but substantially for some of them, especially Kragnes and Morken townships. These costs must be considered when assessing future operations of the Clay County gravel pit.

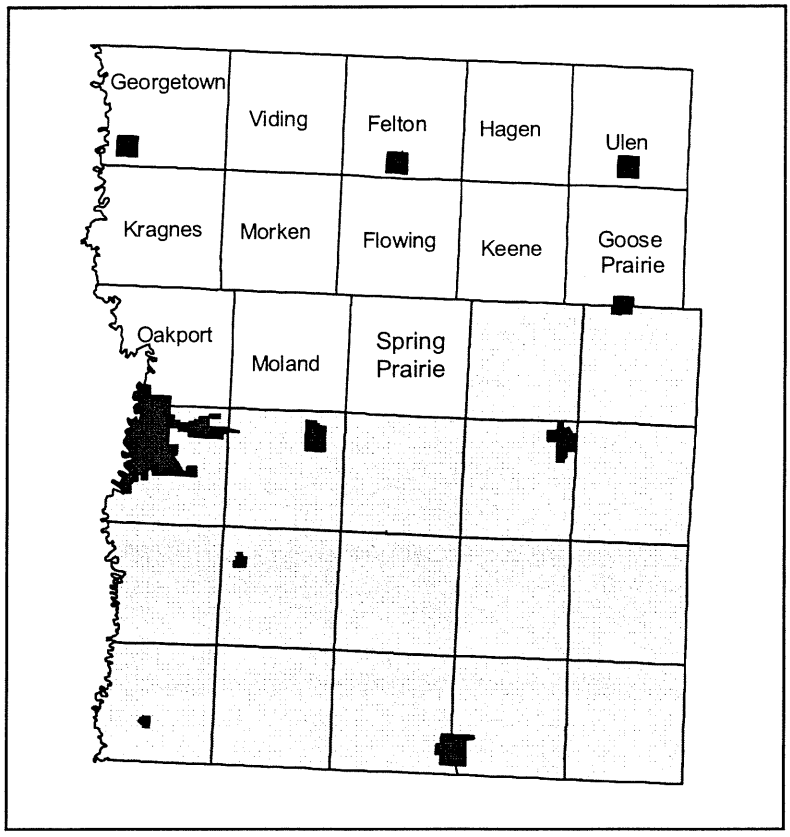


Figure 30: Townships that purchased Class 5 from the county pit in 2000.

Road Gravel from County Pit - Current						Gravel from Private Pit - Estimated			
Township	Mat'l cost /cu. yd.	Miles	Haul Cost	Township Total Cost per Yard	County Total Cost per Yard	Mat'l cost /cu. yd.	Miles	Haul Cost	Cost/yd.
Georgetown	$2.25	17	$2.98	$5.23	$4.93	$3.50	24	$4.20	$7.70
Viding	$2.25	13	$2.28	$4.53	$4.23	$3.50	19	$3.33	$6.83
Felton	$2.25	7	$1.70	$3.95	$3.65	$3.50	13	$2.28	$5.78
Hagen	$2.25	7	$1.70	$3.95	$3.65	$3.50	8	$1.40	$4.90
Ulen	$2.25	12	$2.10	$4.35	$4.05	$3.50	8	$1.40	$4.90
Kragnes	$2.25	13	$2.28	$4.53	$4.23	$3.50	28	$4.90	$8.40
Morken	$2.25	10	$1.75	$4.00	$3.70	$3.50	23	$4.03	$7.53
Flowing	$2.25	5	$1.70	$3.95	$3.65	$3.50	14	$2.45	$5.95
Keene	$2.25	8	$1.40	$3.65	$3.35	$3.50	6	$2.10	$5.60
Goose Prairie	$2.25	13	$2.28	$4.53	$4.23	$3.50	6	$2.10	$5.60
Oakport	$2.25	21	$3.68	$5.93	$5.63	$3.50	25	$4.38	$7.88
Moland	$2.25	15	$2.63	$4.88	$4.58	$3.50	20	$3.50	$7.00
Spring Prairie	$2.25	12	$2.10	$4.35	$4.05	$3.50	18	$3.15	$6.65
Average Cost per yard				$4.45	$4.15	Average cost per yard			$6.52

Table 6: Comparison of Class 5 costs purchased from county mine versus private. Note that the townships pay a $0.30 royalty per yard to the county. Haul costs are $1.70 per yard for 1-7 miles and $0.175 per yard mile for distances greater than 7 miles.

E. Clay County Mining Alternatives for the Current Footprint and Contiguous Lands

Since the county is running out of material above the water table, the stewardship committee studied four alternatives for future operations of the county mine and the lands around it:

1. Continue to supply Class 5 out of the existing pit for county and township roads.
    a. When surface supplies are depleted in 2001-02, mine below the water table and mix suitable overburden from the site to meet Class 5 specifications.
    b. Purchase fines when the local supply of overburden is depleted.
    c. Lease the mine to private industry after material accessible to a dragline is depleted and buy from the private market.
2. Continue to supply Class 5 from the county pit until the local supply of fines is depleted, then lease the mine to private industry.
    a. When surface supplies are depleted in 2001-02, mine below the water table and mix suitable overburden from the site to meet Class 5 specifications.
    b. Lease the mine to private industry after local fines are depleted and buy Class 5 from the private market.
3. Continue surface mining by expanding the footprint north or east.
4. Lease the existing pit to private industry immediately. Purchase Class 5 from the private market.

Each of these alternatives will have costs and timetables associated with it such as the supply of fines to mix with material mined below the water table. It is not certain that the overburden available onsite will be suitable for mixing Class 5. In that event, the county will need to import suitable fines. The first two alternatives assume the county will continue to mine the existing footprint for Class 5 until the local supply of fines is depleted from existing spoil piles. They differ in the duration of mining for local needs, and in strategies for the future.

MINING ALTERNATIVE 1: Continue to Mine for County Use

The county will begin mining below the water table in 2002 and the mined material will need to be crushed and mixed with fines available onsite from existing spoil piles (excavated overburden) to meet Class 5 specifications. Based on analysis of the overburden found in drill holes 5, 8, and 9 (Fig. 27), it should comprise 25% of the mix. The county mine in its present form is estimated to have 6.5 million cubic yards of aggregate after allowing for setbacks and slopes. A dragline will be used to mine material below the water table. Its effective reach is 30' deep yielding an estimated 3.3 million cubic yards. The supply of fines from overburden is approximately 400,000 cubic yards (c.y.). The county mines an average of 100,000 c.y. per year. Assuming the fines are suitable for Class 5 and the county can mix 3 parts gravel to 1 part fines, the local supply of fines will be depleted in 16* years. In this time, 1.2 million c.y. of aggregate will have been excavated below the water table. The cost of this process is calculated based on **current dollar values**. This estimate was developed for comparison purposes only and should not be used for budgetary considerations.

*400,000 c.y./25,000 yds per year = 16 years of material. Use will begin in 2002 and end ~2017.

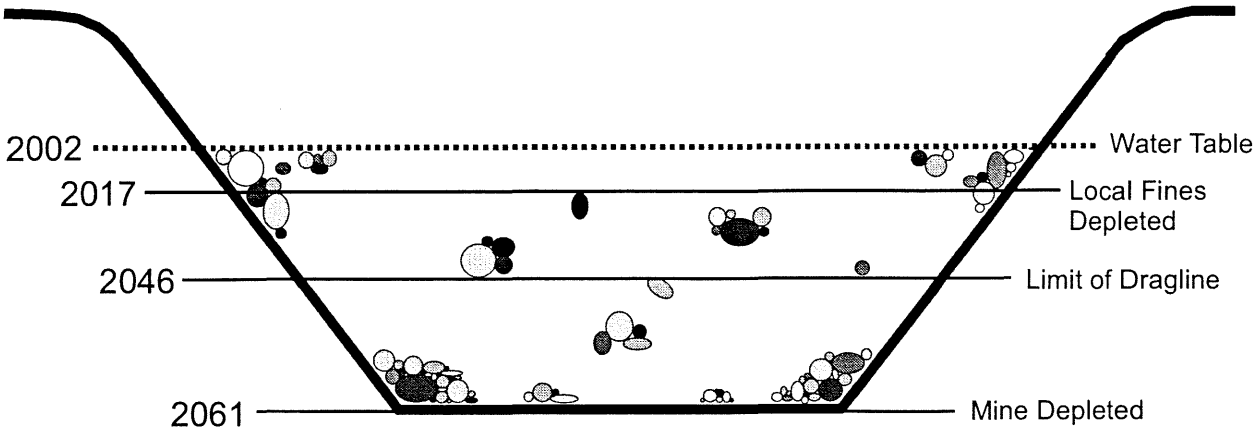


Figure 31: Diagram of mining sequence for Alternative 1

a. Years 2002 through 2017:

Mine aggregate below the water (75% of 100,000 cubic yards):
$2.45/yd x 75,000 yds = $183,750
Mine fine material (25% of 100,000 cubic yards):
$1.45/yd x 25,000 yds = $36,250
Crush and stockpile all materials:
$2/yd = $200,000
Blend all materials:
$0.30/yd = $30,000
Total cost:
$450,000 per year or $4.50 per cubic yard

Note that the costs will double what the county and townships currently pay because the county operator must mine below the water table (from 2.25/c.y. to $4.50/c.y.). Table 7 calculates the estimated costs of this phase to the county and townships.

Township	Mat'l $ /cu yd	miles	haul cost	Township total cost/yd	County
Georgetown	$4.50	17	$2.98	$7.78	$7.48
Viding	$4.50	13	$2.28	$7.08	$6.78
Felton	$4.50	7	$1.70	$6.50	$6.20
Hagen	$4.50	7	$1.70	$6.50	$6.20
Ulen	$4.50	12	$2.10	$6.90	$6.60
Kragnes	$4.50	13	$2.28	$7.08	$6.78
Morken	$4.50	10	$1.75	$6.55	$6.25
Flowing	$4.50	5	$1.70	$6.50	$6.20
Keene	$4.50	8	$1.40	$6.20	$5.90
Goose Prairie	$4.50	13	$2.28	$7.08	$6.78
Oakport	$4.50	21	$3.68	$8.48	$8.18
Moland	$4.50	15	$2.63	$7.43	$7.13
Spring Prairie	$4.50	12	$2.10	$6.90	$6.60
Average cost per yard				$7.00	$6.70
Annual cost (40,000 c.y.)				$280,000	
County cost (60,000 c.y.)					$402,000
County royalty adjustment ($12,000)					$390,000

Table 7: Compares costs for townships and county. Townships pay $0.30 royalty per yard.

b. Mining Alternative 1: 2018 - 2045

Once the local supply of fines is depleted, the county will need to import fines from other sources. The stewardship committee estimates that an additional 2.1 million c.y. will still be accessible to a dragline. At the current consumption level of 100,000 yards per year the county could mine out of the pit for 28 years with the addition of 700,000 c.y. of suitable fines from another location before the dragline limit would be reached. The calculations below estimate these costs based on current dollar values and assume the import of fines to the county mine site.

Years 2018-2045:

Extract material below the water (75% of 100,000 cubic yards):
$2.45/yd x 75,000 yds = $183,750
Import fines (25% of 100,000 cubic yards):
$4.70/yd x 25,000 yds = $117,500
Crush and stockpile all materials:
$2/yd = $200,000
Mix all materials:
$0.30/yd = $30,000
Production cost:
$531,250 or $5.31 per cubic yard

Table 8 calculates the estimated costs of this phase to the county and townships.

Township	Mat'l $ /cu. yd.	miles	haul $	Township	County total cost/c.y.
Georgetown	$5.31	17	$2.98	$8.59	$8.29
Viding	$5.31	13	$2.28	$7.89	$7.59
Felton	$5.31	7	$1.70	$7.31	$7.01
Hagen	$5.31	7	$1.70	$7.31	$7.01
Ulen	$5.31	12	$2.10	$7.71	$7.41
Kragnes	$5.31	13	$2.28	$7.89	$7.59
Morken	$5.31	10	$1.75	$7.36	$7.06
Flowing	$5.31	5	$1.70	$7.31	$7.01
Keene	$5.31	8	$1.40	$7.01	$6.71
Goose Prairie	$5.31	13	$2.28	$7.89	$7.59
Oakport	$5.31	21	$3.68	$9.29	$8.99
Moland	$5.31	15	$2.63	$8.24	$7.94
Spring Prairie	$5.31	12	$2.10	$7.71	$7.41
Average cost per yard				$7.81	$7.51
Annual cost				$312,000	$451,000
County Royalty Adjustment ($12,000)					$439,000

Table 8: Compares costs of importing fines for county and townships. Note that townships pay $0.30 royalty per yard to the county. Transportation (haul) costs $1.70 per yard up to 7 miles. Distances greater than 7 miles are calculated at $0.175 per yard mile.

c. Mining Alternative 1: 2046-2061 (material from private pits)

The remaining 3.2 million yards not accessible to the dragline could be leased to private industry. By setting up a sauerman, private industry could potentially mine 200,000 c.y. per year. If, for example, the county charged a royalty rate of $1.25 per cubic yard, the county could realize annual royalty payments of $250,000 in today's dollar value. If private industry mined 200,000 yards per year, the estimated aggregate volume would be depleted in ~16 years yielding the county approximately $4 million.

Years 2046 – 2061, lease the county mine to private industry:
200,000 c.y./yr @ $1.25/c.y. royalty to county
= $250,000
Purchase 60,000 c.y. for county roads:
$3.50/c.y. x 60,000 c.y. = $210,000/yr
Total cost to county:
$210,000 - $250,000 royalty = surplus of $40,000 /yr.

Table 9 calculates the estimated costs of this phase to the county and townships.

Township	Mat'l $ /cu yd	miles	haul cost	Township & County total cost/yd
Georgetown	$3.50	24	$4.20	$7.70
Viding	$3.50	19	$3.33	$6.83
Felton	$3.50	13	$2.28	$5.78
Hagen	$3.50	8	$1.40	$4.90
Ulen	$3.50	8	$1.40	$4.90
Kragnes	$3.50	28	$4.90	$8.40
Morken	$3.50	23	$4.03	$7.53
Flowing	$3.50	14	$2.45	$5.95
Keene	$3.50	6	$2.10	$5.60
Goose Prairie	$3.50	6	$2.10	$5.60
Oakport	$3.50	25	$4.38	$7.88
Moland	$3.50	20	$3.50	$7.00
Spring Prairie	$3.50	18	$3.15	$6.65
Average cost per yard				$6.52
Annual cost to Townships				$261,000
Annual cost to County				$391,000
County Royalty adjustment ($250,000)				$141,000

Table 9: Compares costs of leasing the county mine for county and townships

If one compares the costs of each phase, importing fines is the most expensive, both in average cost and totals. It is unlikely that the townships will continue purchasing road gravel from the county once this happens, so the $12,000 royalty fee will probably not be collected. From a general point of view, importing fines equates to hauling the material twice, thus increasing pollution, safety liability, and wear on the county roads. It is possible that fines may be available from the School Trust Fund if the estimated 270,000 c.y. of spoil (Walk, 1997) is not used for reclamation of the site. It is also not known if the material would be suitable for this use. If it were, the cost of importing material would be less than currently stated.

Clay County Mining Alternatives

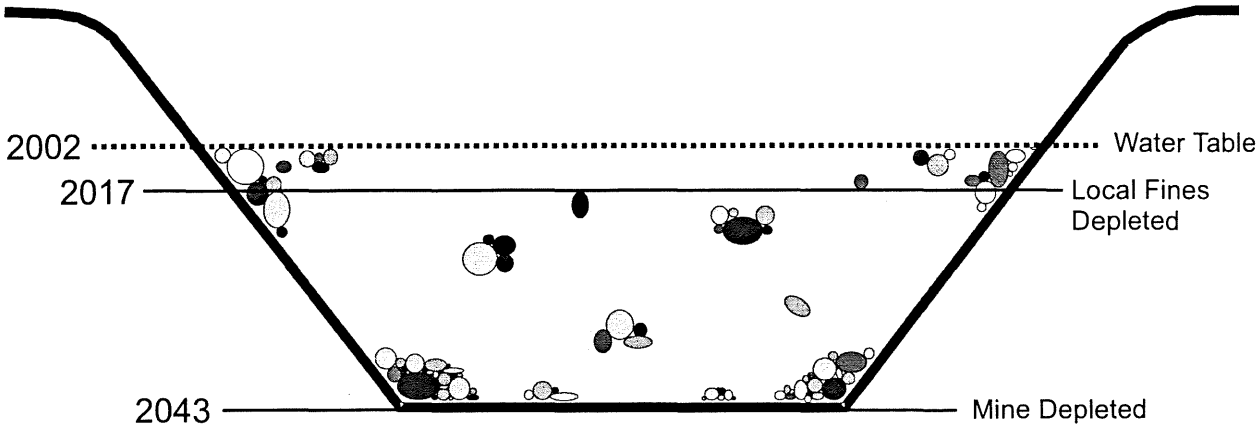


Figure 32: Diagram of mining sequence for Alternative 2.

MINING ALTERNATIVE 2: Lease to Private Industry 2018

Supply Class 5 for county and township needs until the local supply of fines is depleted, then lease the pit to a private entity and purchase Class 5 road gravel from private sources. The cost for this will be the same as alternative one until the fines are depleted, then the county will lease the pit and buy Class 5 on the open market. The estimates below are based on today's dollar value for comparison only. They cannot be used for budgetary considerations or valuation of the aggregate deposit.

a. Years 2002 through 2017 (same as Alternative 1):

Extract material below the water (75% of 100,000 cubic yards):
$2.45/yd x 75,000 yds = $183,750
Extract overburden (25% of 100,000 cubic yards):
$1.45/yd x 25,000 yds = $36,250
Crush and stockpile all materials:
$2/yd = $200,000
Mix all materials:
$0.30/yd = $30,000
Total production cost:
$450,000 per year or $4.50 per cubic yard

Approximately 5.3 million yards would remain after the fines are depleted for private industry. At a mining rate of 200,000 yards per year, private industry could operate in the pit for ~26 years. Excluding compound interest the county would earn over $6 million in royalties from a private lease of the mine. This money could be applied directly to gravel purchase or be invested in a gravel endowment to provide for future needs. Table 10 estimates the costs of this phase to the county and townships.

b. Mining Alternative 2: 2018-2034 (material from private pits)

Township	Mat'l $ /cu yd	miles	haul cost	Township total cost/yd	County total cost/yd
Georgetown	$4.50	17	$2.98	$7.78	$7.48
Viding	$4.50	13	$2.28	$7.08	$6.78
Felton	$4.50	7	$1.70	$6.50	$6.20
Hagen	$4.50	7	$1.70	$6.50	$6.20
Ulen	$4.50	12	$2.10	$6.90	$6.60
Kragnes	$4.50	13	$2.28	$7.08	$6.78
Morken	$4.50	10	$1.75	$6.55	$6.25
Flowing	$4.50	5	$1.70	$6.50	$6.20
Keene	$4.50	8	$1.40	$6.20	$5.90
Goose Prairie	$4.50	13	$2.28	$7.08	$6.78
Oakport	$4.50	21	$3.68	$8.48	$8.18
Moland	$4.50	15	$2.63	$7.43	$7.13
Spring Prairie	$4.50	12	$2.10	$6.90	$6.60
Average cost per yard				$7.00	$6.70
Annual cost (40,000 c.y.)				$280,000	
County cost (60,000 c.y.)					$402,000
County royalty adjustment ($12,000)					$390,000

Table 10: Costs of mining below the water table

b. Years 2018-2034:

Lease the county pit to private industry:

200,000 cubic yards/year @ $1.25/yd royalty to county = $250,000

Purchase ~60,000 yds for county roads from private market (see Table 11 for average cost):

$6.52/yd x 60,000 yds = $391,200 /yr

Royalty applied to road material costs:

$391,200 – $250,000 royalties = $141,000 per year

The townships would continue to purchase Class 5 on the open market at the same cost.

Township	Mat'l $/cu yd	miles	haul cost	total cost/yd
Georgetown	$3.50	24	$4.20	$7.70
Viding	$3.50	19	$3.33	$6.83
Felton	$3.50	13	$2.28	$5.78
Hagen	$3.50	8	$1.40	$4.90
Ulen	$3.50	8	$1.40	$4.90
Kragnes	$3.50	28	$4.90	$8.40
Morken	$3.50	23	$4.03	$7.53
Flowing	$3.50	14	$2.45	$5.95
Keene	$3.50	6	$2.10	$5.60
Goose Prairie	$3.50	6	$2.10	$5.60
Oakport	$3.50	25	$4.38	$7.88
Moland	$3.50	20	$3.50	$7.00
Spring Prairie	$3.50	18	$3.15	$6.65
Average cost per yard				$6.52
Annual Cost to county (60,000 yds/year)				$391,000
Annual Cost to 13 townships (40,000 yds/year)				$261,000
County royalty adjustment ($250,000)				$141,000

Table 11: Costs of purchasing gravel from the private market and leasing the county mine.

Comments:
This alternative is sound if an alternate source of Class 5 is available within a reasonable travel distance. Material that is suitable for concrete and in short supply regionally will be used for that purpose thus reducing longer haul distances from Becker County and Jamestown, ND to the Clay-Cass County markets.

Mining Alternative 3: Continue surface mining: expand the county mine north or east

Since costs increase considerably when mining below the water table the county could expand the footprint north or east where additional aggregate resources lie above the water table. The county tried this in July of 2000 when officials applied for an endangered species takings permit from DNR to expand the pit north and west to the existing road. A permit was granted to expand the pit up to 9 acres, but only to the extent necessary to provide for the gravel needs of the county and the townships. The permit extends through the end of 2001. Under the terms of this permit, the county mitigated the loss of habitat and mortality for impacted species like the Dakota skipper by extending the lease on portions of Bicentennial Prairie SNA. Prior to issuing any future endangered species permits, the DNR and county agreed that the Felton Prairie Stewardship Plan must be completed and the county and state must have negotiated a long-term mining plan for area. This case illustrates the compromises and potential limitations to expansion of the existing footprint, especially to the north. Because of the species dependent on the prairie north of the current footprint, it is unlikely that the county will be able to negotiate a mitigation plan for the permit as advantageous as the last one issued. In addition to applying for a takings permit if the county expanded the mine north, the county would also need to prepare a fen management plan. The management plan is required under Minnesota law in order to determine whether proposed mining could be done without impacting the fens. According to the fen study conducted by DNR, this would require staying 10' above the water table. The quantity of gravel available above this level (Figure 29) may not justify the expansion costs and regulatory processes.

MINING ALTERNATIVE 4: Lease Couny Pit Immediately and Purchase from Private Market

Lease the county pit to a private entity as soon as possible and purchase Class 5 road gravel from the private market. The estimates below are based on today's dollar value for comparison only. They cannot be used for budgetary considerations or valuation of the aggregate deposit.

Years 2002 - 2034:

Lease the county pit to private industry:
200,000 cubic yards/year @ $1.25/yd. royalty to county = $250,000
Purchase ~60,000 cubic yards for county roads
$6.52/yd x 60,000 yds = $391,200 /yr
Royalty applied to road material costs:
$391,200 – $250,000 royalties = $141,000 per year

The townships would continue to purchase Class 5 on the open market at the same cost as above. See Table 11 for a cost estimate for private purchase of Class 5 road gravel.

F. Assessment of Mining Alternatives:

Below is a summary of the costs to the county drawn from the previous alternatives for each mining activity.

	Mine above Water	Mine below water & mix local fines	Mine below water & import fines	lease mine, private purchase
Avg. cost/c.y.	$4.15	$6.70	$7.51	$6.52
Annual Cost	$249,000	$402,000	$451,000	$391,000
Potential Royalty	$12,000	$12,000	$12,000	$250,000
Net Cost*	$237,000	$390,000	$439,000	$141,000

*If royalty is applied to aggregate costs

Of the alternatives analyzed, surface mining is the least expensive, however it causes the most damage to habitat and rare species. The legal and administrative costs of applying for the necessary permits and mitigation have not been calculated and would be difficult to estimate, although they will be a legitimate expense for this alternative. Of the others, purchasing gravel from the private market is slightly less expensive (-$10,800) than mining below the water and mixing local fines. Mining below the water table and importing fines would cost more than purchasing road gravel from private sources based on current market conditions. Leasing the county pit and applying the royalties to county gravel purchases would be the least expensive alternative. If the royalties from leasing the pit were invested into a gravel endowment fund, the return would vary based on the length of time the pit is leased out and the volume of aggregate mined from it. It is difficult to accurately estimate the cash flow from these royalties since the volume of material extracted is based on contemporary economic demand for the aggregate. The calculations below cover a range of potential revenues from a gravel endowment fund based on the mining alternatives (duration of royalty collection), the level of annual contributions ($100,000 or $200,000) and rates of return (4% or 6%).

- Lease the mine immediately (Mining Alternative 4):
  - 32 yrs @ $200,000/yr. = $6.5 million total
  - If the county invested $200,000 annually for 32 years:
    - $13,662.240 @ 4% compounded
    - $20,651,590 @ 6% compounded
  - Invest $100,000 annually:
    - $6,831120 @ 4%
    - $10,325,795 @ 6%
- Lease after local fines are depleted (Mining Alternative 2):
  - 26.5 yrs @ $200,000/yr. = $5.3 million total
  - If the county invested $200,000 annually for 26.5 years:
    - $9,982,318 @ 4%
    - $13,924,219 @ 6%
  - Investing $100,000 annually:
    - $4,991,159 @ 4%
    - $6,962,110 @ 6%
- Lease the mine after material accessible to a dragline is depleted (Mining Alternative 1):
  - 16 yrs @ $200,000/yr. = $3.2 million total. $200,000 invested annually for 16 years:
    - $4,851031 @ 4%
    - $5,872,399 @ 6%
  - Investing $100,000:
    - $2,425,515 @ 4%
    - $2,936,200 @ 6%

G. MINING RECOMMENDATIONS

Costs of mining out of the current footprint will continue to rise because surface supplies in the present mine have been exhausted. Mining below the water table will inevitably lead to higher production costs as seen in the calculations for Alternative 1. Since little information is available on the future availability of Class 5 road gravel, predicting the future purchase price from the private sector is difficult. However, the county has an opportunity to establish a fund that will provide for future gravel needs by:

- investing royalties earned from leasing the current mine; or
- investing proceeds from the sale of county land outside the current mine footprint.

Based on information available to the committee, it recommends the following management strategies for meeting county gravel needs and managing county lands.

1. Current County Mine Management

The committee recommends two alternate courses of action concerning management of the current gravel pit for consideration by the Clay County Board of Commissioners.

a) The county should continue to mine Class 5 road gravel from the county pit until the production costs exceed the purchase price from a private supplier. When the production cost for county gravel exceeds the purchase price from the private sector, the mine should be leased to private industry. The royalties collected could be used to:

- offset the purchase price of road gravel, or
- be invested in a gravel endowment fund that would cover future purchases, or
- acquire an alternate mine site.

b) The county should lease the existing footprint immediately and purchase Class 5 road gravel from the private market. Royalties collected from leasing may be used in the same manner described above.

2. Management of County Lands beyond the Current Footprint

The county owns and manages approximately 560 acres of land beyond the mine footprint. Some of this land holds aggregate resources according to the Aggregate Resource Evaluation (MN DNR, 2000). Most of the land supports important biological resources. The committee recommends two courses of action for the Clay County Board of Commissioner's consideration:

a) Follow the management recommendations for individual parcels described in the stewardship section of this report.

b) Appraise the value of county land beyond the mine footprint and explore its sale to a conservation entity. The proceeds of such a sale could be invested in a gravel endowment to provide for the county's future needs.

The committee hired a licensed appraiser with experience in aggregate resource assessment to offer a letter of opinion on the value of various Clay County parcels delineated in the Aggregate Resource Evaluation. A letter of opinion does not convey the same level of accuracy or confidence as an appraisal. See Figure 27 for the location of the units listed below:

Unit 1B:	$1,980,855
Unit 1C:	$2,773,950
NW 40 acres of Bicentennial:	$2,549,571
Total:	$2,771,571

These figures are based on an annual extraction rate of 200,000 c.y. and 9% annual depreciation. The total value appears low because it reflects the greater length of time required to mine the entire area thus increasing the depreciation amount.

An alternate method of valuing aggregate resource land is used by the industry for negotiating with landowners. Under this method the current market value of the estimated aggregate volume is calculated and the land valued at 25% of that product. The results of this calculation are given below based on volumes estimated in the Aggregate Resource Evaluation (summarized in Table 3 of this document) and a market value of $1.25 per cubic yard:

Area 1B:	2,900,000(1.25)	=3,625,000(.25)	=$906,250
Area 1C:	15,300,000(1.25)	=19,125,000(.25)	=$4,781,250
Bicentennial:	5,800,000(1.25)	=7,250,000(.25)	=$1,812,500
Total:			=$7,500,000

Since the aggregate industry is aware of the environment sensitivity of the county's land and its potential for regulatory oversight, it is unlikely that this sum could be negotiated; however it may be referenced in negotiations with potential conservation parties concerning the value of the resource.

If the proceeds from land sales were deposited in a gravel endowment fund, the revenues generated over 32 years are estimated below:

- $3 million purchase price would yield
  - $10.8 million @ 4%
  - $20.4 million @6%
- $5 million purchase price would yield
  - $17.9 million @ 4%
  - $33.9 million @ 6%
- $7.5 million purchase price would yield
  - $26.9 million @ 4%
  - $50.9 million @ 6%

Given the current regulatory environment and the general concern about future gravel supplies, the county should consider a range of alternatives for the use of lands beyond the current mine footprint. The income generated from sale of these lands could be used to acquire other aggregate resources in the county or purchase gravel from the private market.

V. FELTON PRAIRIE STEWARDSHIP PLAN

The following observations led to the development and funding of the Felton Prairie Stewardship Plan and guided the actions recommended for each parcel in the following pages:

- Aggregate, especially concrete grade, is a rare commodity in the Red River Valley and is needed to maintain economic development and prosperity.
- Native prairie has been largely destroyed in the state of Minnesota and what little is left must be preserved for biodiversity, research, and natural heritage appreciation.
- The presence of state and federally listed endangered and threatened species requires state permitting and mitigation for any mortality or alteration of habitat.
- The calcareous fens are protected and regulated at the state level and any impacts to them require, at a minimum, the development of a fen management plan and mitigation.

Where prairie and aggregate resources coincide, conflict arises. An overlay of biological resources and aggregate in Figure 33 indicates where these conflicts are greatest. The same is true of aggregate below the water table in recharge zones of the calcareous fens. The stewardship committee developed the overlay in Figure 33 for the study area and analyzed it below.

A. Prairie – Aggregate Conflict

The areas identified in Figure 31 are the same used in the Aggregate Resource Evaluation (MN DNR, 2000). The committee focused on Area 1 because this is the area of significant aggregate and potentially significant conflict. The vertical gray striping represents good Dakota skipper habitat. Point observations (some of the blue stars) record the sighting of particular species but should not be interpreted as the only occurrences or the exact number of species in the area. Area 1 reveals an aggregate deposit running under Dakota skipper habitat through mesic to dry prairie. The greatest land use conflict between mining and biological resource protection occurs here. The stewardship committee studied this area in great detail and broke it into smaller parcels for planning purposes after recognizing the conflict. Area 3 also illustrates conflict on the western half of the property. Area 2 has little aggregate but is a likely stockpile and aggregate plant location if the county pit is leased to private industry. Area 4 offers the least conflict because there is no significant aggregate other than existing disturbed areas that are not mapped.

B. Fen – Aggregate Conflict

Based on the fen study prepared by DNR Division of Waters, a significant disruption of ground water supply to both fens could result from mining below the water table. Because ground water fluctuates seasonally and cyclically through dry and wet years, a groundwater protection buffer of 10' above the high water table level recorded by monitoring wells is recommended. Based on this threshold most of the aggregate resource north of the county pit cannot be mined without impacting the fens and requiring the development of a fen management plan.

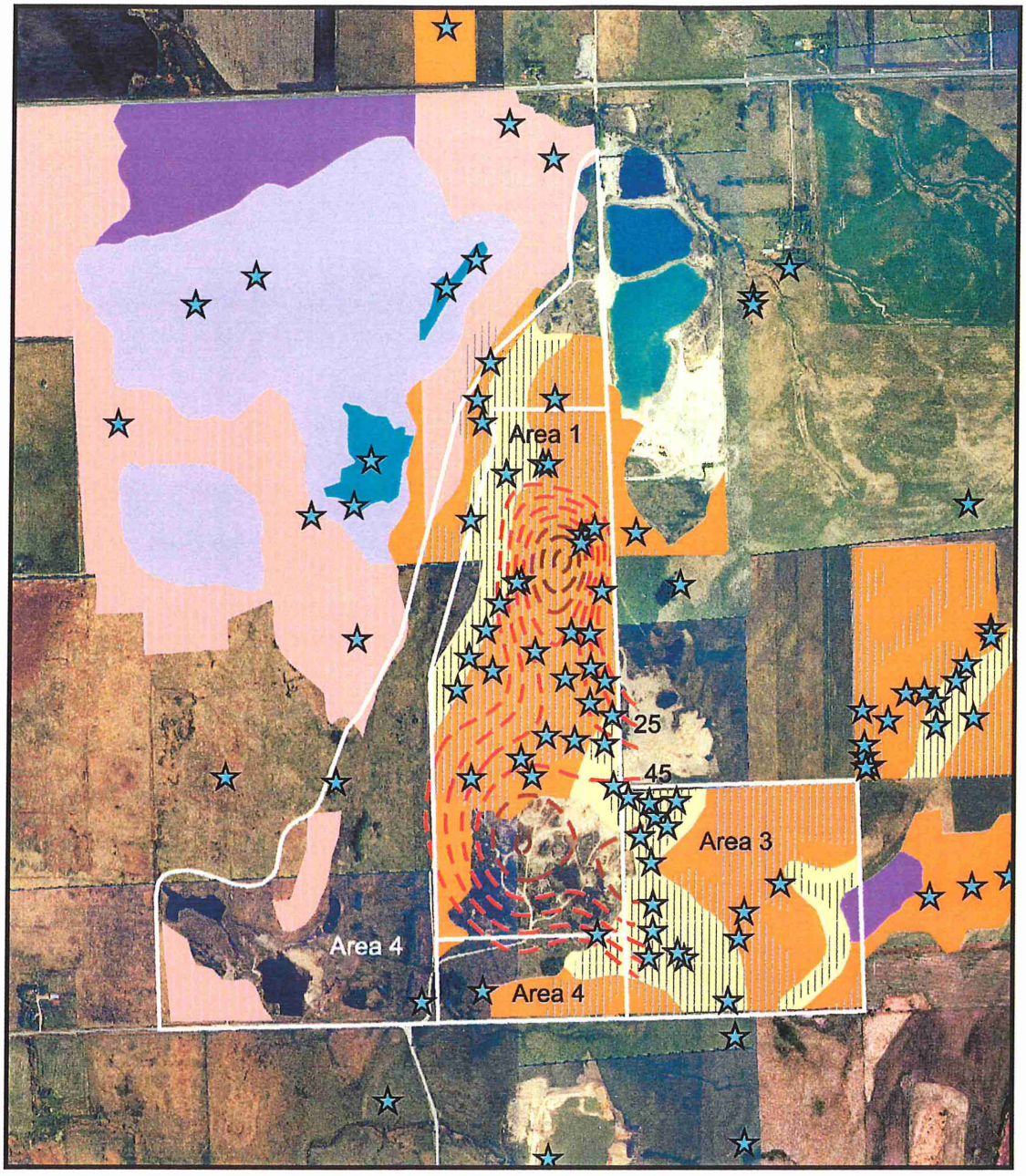


Figure 33: Graphic showing conflicts between aggregate and prairie resources. Area 1 north of the current mine and the corridor to Bicentennial Prairie SNA (Area 3) have good aggregate and support rare species. Mining below the ground water buffer elevation in these areas would also impact both fens. Contours symbolize overburden to aggregate ratio found on Figure 28.

C. PLANNING CRITERIA

Guidelines need to be established for evaluating land use alternatives. In the case of public lands in the study area the land use alternatives include mining, mine reclamation, prairie preservation, and prairie restoration. The recommended land uses outlined in the stewardship plan are based on the following criteria:

- Identify aggregate deposits that will supply the county's gravel needs for current and future needs.
- Maximize aggregate mining in severely degraded or non-prairie habitat and where it is most economically feasible.
- Avoid further fragmentation and loss of the prairie habitat:
  - prioritize restoration efforts to establish corridors or reduce fragmentation;
  - establish a mining and reclamation sequence that will minimize habitat fragmentation.
- Avoid any action that would impact the calcareous fens.
- View public lands with the same expectations and requirements as private lands.
- Address local and regional concerns along with post mining use.
- Extend the planning horizon beyond the aggregate supply in the current Clay County pit.

Based on the committee's analysis of aggregate and biological resources, land use recommendations were developed for the parcels identified in Figure 35. Areas with important biological resources such as mesic prairie, but without significant gravel were labeled "preserve" and recommended for permanent protection. Areas with both gravel and sensitive biological resources were labeled "preserve" but for a length of time based on the parcel's proximity to the current footprint and the desirability of the aggregate resource. Timeframes ranged from 35 years when the county would have nearly depleted the aggregate accessible to a dragline in the current footprint to 75 years when the footprint and proximate parcels would likely be depleted. These environmentally sensitive aggregate reserves should be preserved by lease, easement, or other protection agreement similar to Bicentennial Prairie SNA.

Areas identified for mining are either existing mines or disturbed land with economically viable aggregate resources. These require mining and reclamation plans not included in this document. The remaining parcels were designated restore or reclaim. "Reclaim" areas are exhausted gravel pits or spoil piles. Vegetation used in the reclamation process should be native species of local origin. "Restore" refers to areas of non-native vegetation such as abandoned agricultural fields. Some of these should be given a priority in restoration because they could serve as valuable links between larger patches of habitat. Other observations are included with each parcel recommendation including an assessment of habitat and species, estimated aggregate resource and quality, impacts to the fen if aggregate were mined below the water table, and general observations on the condition of the parcel. Figure 34 illustrates a composite view of land use designations and boundaries. Below is a summary of those designations:

Mine and Reclaim,	232 acres, 8% of study area
Reclaim abandoned mines & spoil piles,	63 acres, 2% of study area
Restore,	681 acres, 23% of study area
Preserve,	1502 acres, 52% of study area
Preserve or Transfer,	431 acres, 15% of study area

Each land use recommendation covers several discrete parcels. These are identified in Figure 35 by codes for the landowner(s) or management units, the recommended use, and a number. Codes for landowners are C: Clay County, DNR: Dept of Natural Resources, St: State Trust Fund, TNC: The Nature Conservancy. Use codes are MR: Mine and reclaim, PT: preserve or transfer, P: preserve or already protected, RS: restore, and RC: reclaim.

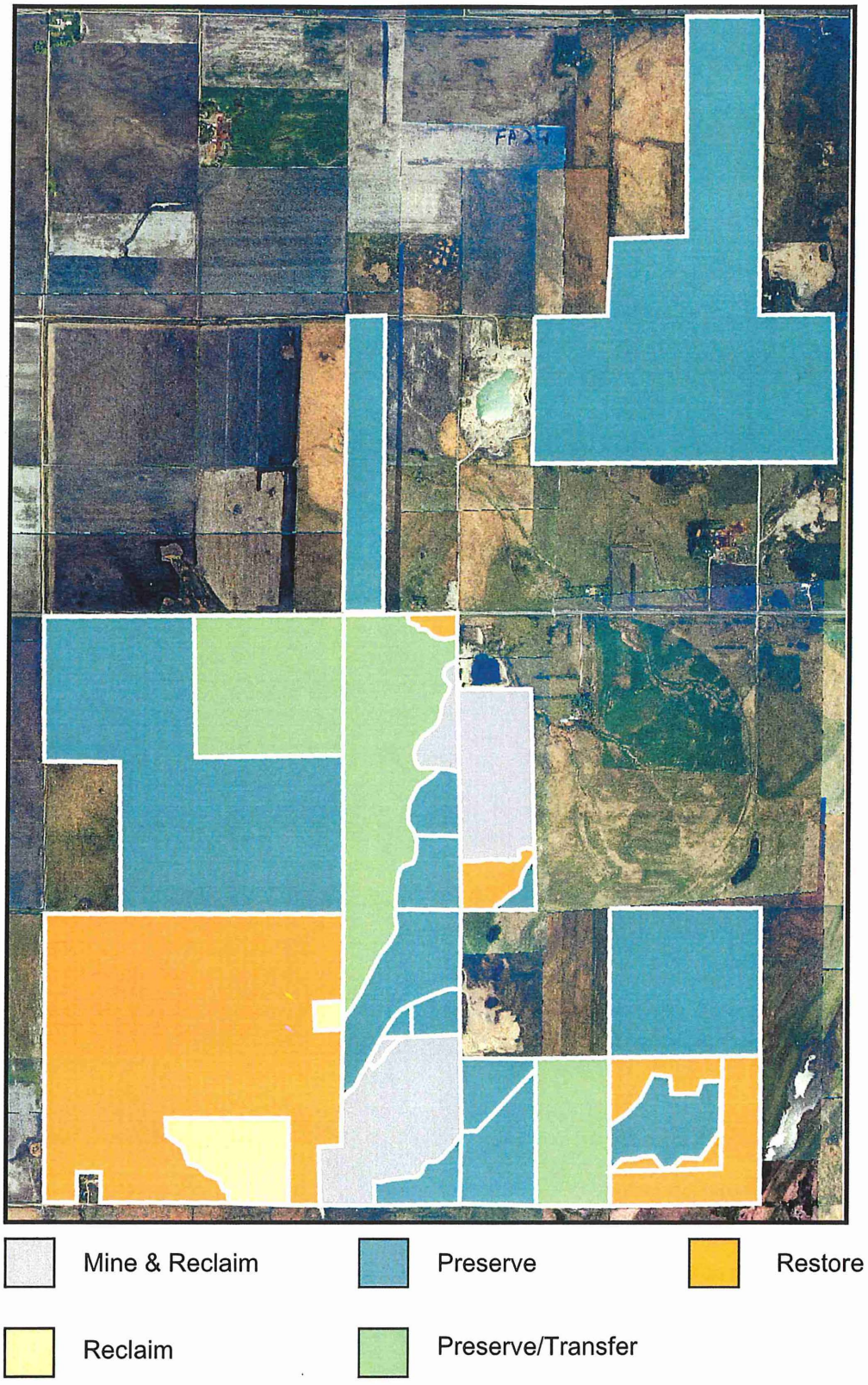


Figure 34: Composite view of land use recommendations for parcels in study area.

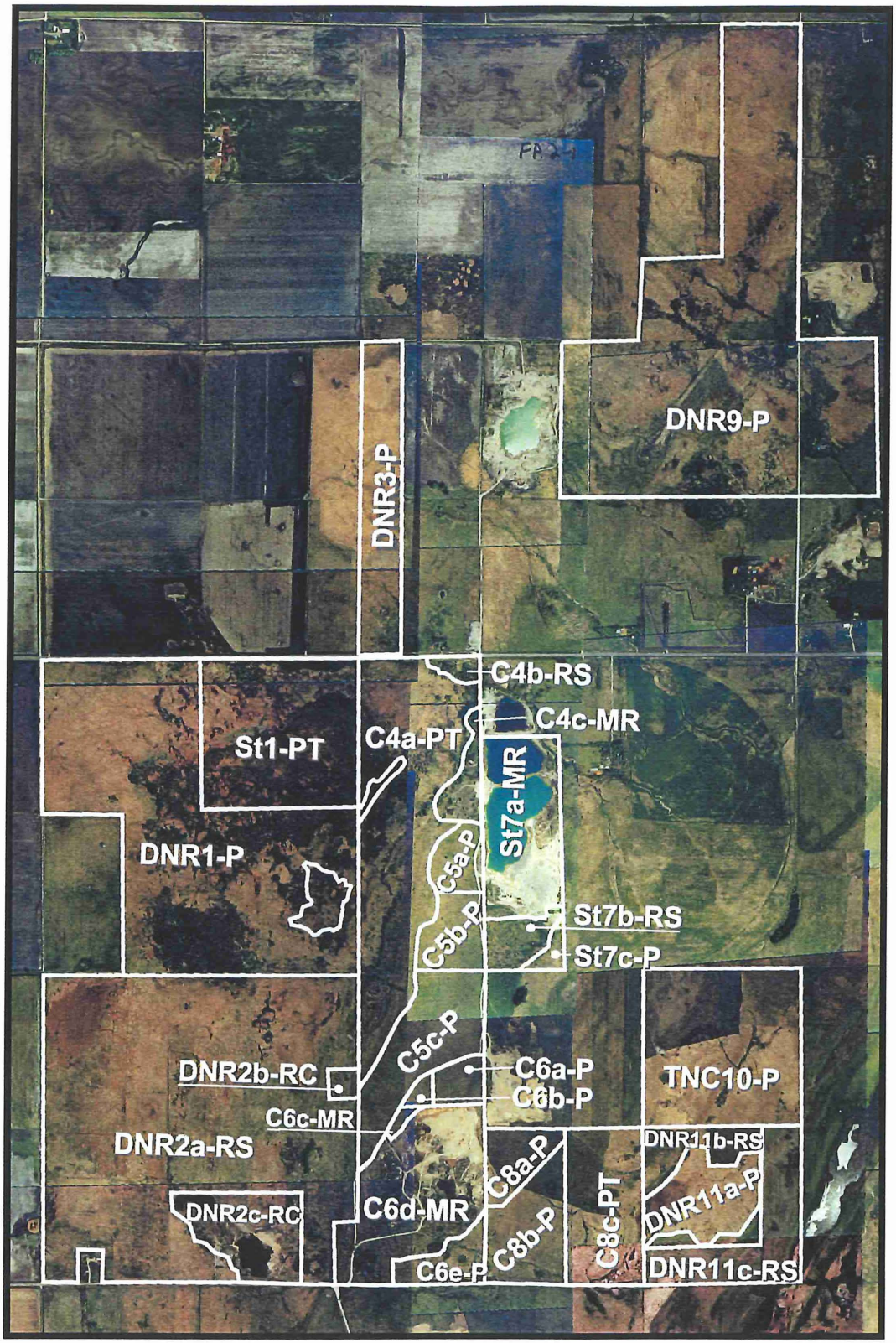


Figure 35: Parcel delineation and codes for landowners. C: Clay County, DNR: Dept of Natural Resources, St: State Trust Fund, TNC: The Nature Conservancy. Use codes are MR: Mine and reclaim, PT: preserve or transfer, P: preserve or protected, RS: restore, and RC: reclaim.

MINE & RECLAIM

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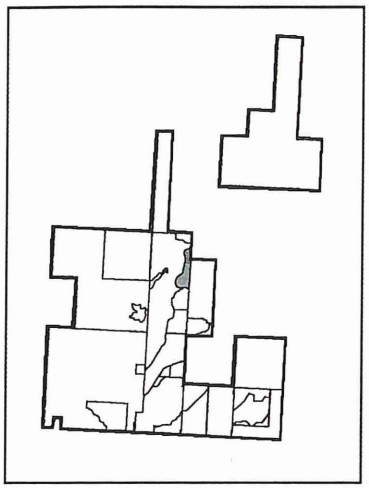
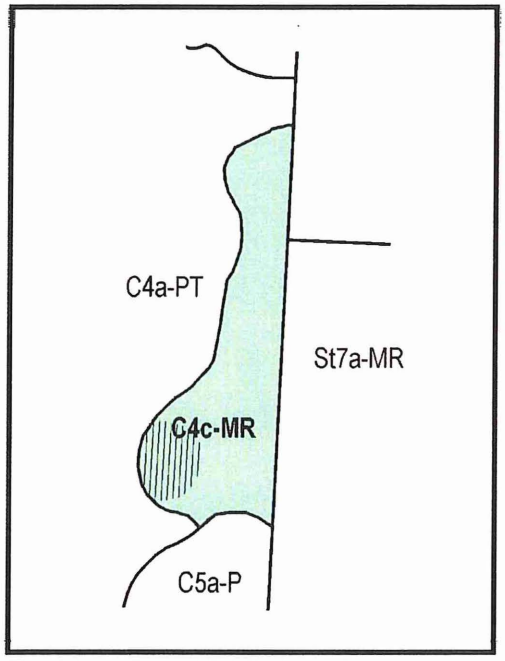
C4c-MR: Mine 10' above Water Table and Reclaim (Section 31, Hagen Township)

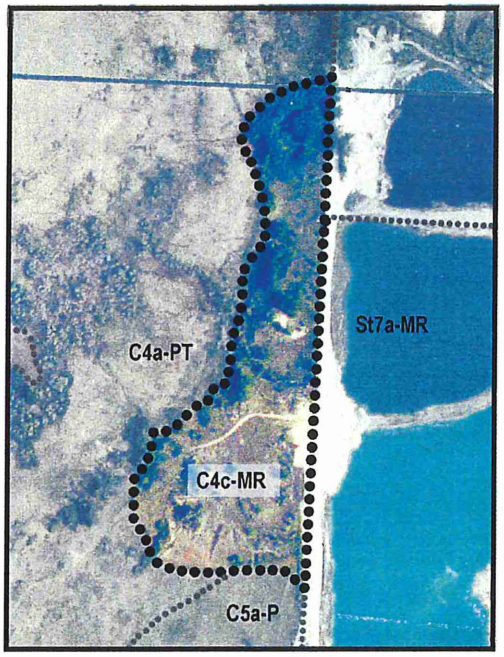


Aggregate Potential:
Presumed high because of proximity to State Trust Fund pit.

Prairie Habitat Assessment:
Area has been disturbed.

Fen Impacts:
Mining below the water table in this area could have significant impacts to the north fen. Mining must be restricted to 10' above the water table established by DNR in order to minimize impacts.





Area Statistics

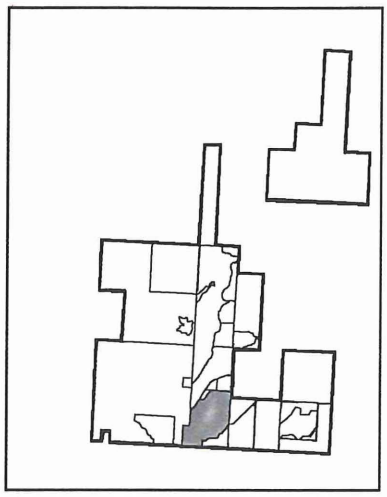
	Landtype	Acres
	Grasslands	20.20
	Total	20.20

Dakota Skipper Habitat

Habitat	Acres
Confirmed Good	0.59
Total	0.59

Recommendations:
All recoverable material 10' above the water table should be mined and the area reclaimed using native seed. Explore permanent protection after mining and reclamation by easement or sale.
Habitat Management: Maintain prairie with prescribed burning. Remove trees by girdling or cutting.

Timeframe: This area should be mined to meet current needs and reclaimed.
Since this area is already disturbed it should be mined and reclaimed in 2001 or 2002.



C6d-MR: Clay County Gravel Mine – Mine Footprint to Depletion and Reclaim (Section 6, Keene Township)

Aggregate Potential:

This area has some of the highest quality aggregate and, because much of the overburden has already been stripped, some of the most accessible material.

Prairie Assessment:

The narrow sliver of dry prairie linking the county land north of the mine and Bicentennial Prairie SNA (C8a-P) should be preserved and used as a buffer in order to minimize fragmentation. Spoil piles are dominated by smooth brome grass, quack grass, sweet clover and other non-native vegetation. Additional problem species include cottonwood trees and scattered leafy spurge patches.

Fen Impacts:

The county may mine within the existing footprint or expand south with minimal impact to the fens. This includes mining below the water table when surface supplies are depleted.

Drillhole Statistics

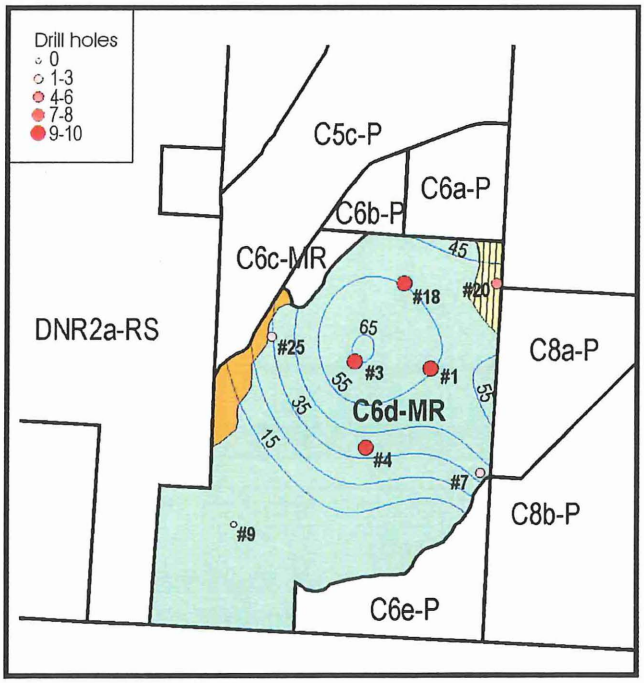
Drillhole	Gravel Thickness	Gravel Above Fen	Aggregate Ratio	Quality
1	55	NA	55.00	9.0
2	54	NA	54.00	9.0
3	65	NA	65.00	10.0
4	63	2.85	31.50	10.0
7	103	NA	51.50	3.0
9	0	NA	0.00	0.0
20	93	NA	46.50	6.0
25	5	NA	5.00	3.0

Area Statistics

	Landtype	Acres
	Mine Operation	115.60
	Dry Prairie (Northwest) Sand Gravel Subtype	2.76
	Mesic Prairie (Northwest)	4.27
	Total	122.63

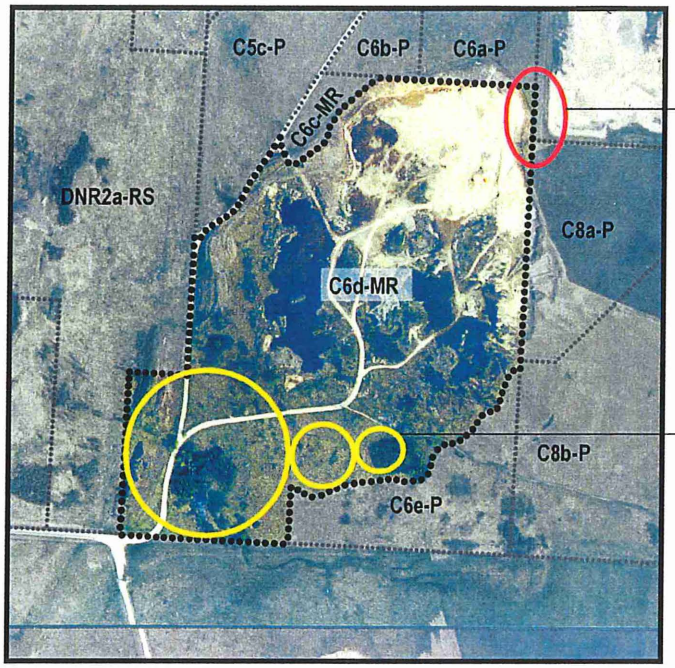
Dakota Skipper Habitat

Habitat	Acres
Confirmed Good	1.84
Total	1.84



Dotted contours represent the overburden to aggregate thickness ratio. Numbers represent the thickness of aggregate per foot of overburden.

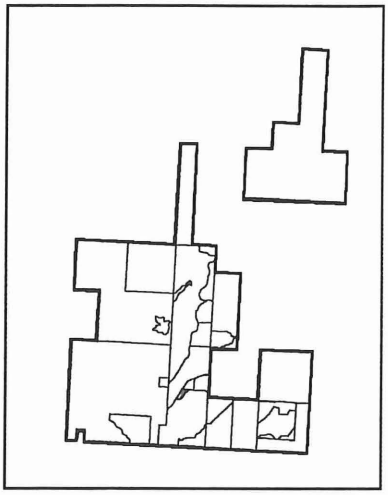
Drillhole symbols are scaled and colored to represent the committee's estimate of the deposit quality. Quality increases with circle size and saturation.



Recommendations:
Expand area for stockpiles and processing plant on disturbed land and consolidate existing spoil piles. Maintain access to Bicentennial Prairie SNA unless otherwise provided.

Habitat Management:
Remove trees by cutting or girdling and consolidate existing spoil piles. Control leafy spurge and other exotic species with chemical or biological controls. Native species should be used for reclamation per mining plan.

Timeframe:
Depending on how the county operates this mine, it could supply Class 5 for approximately 40 years. After depletion it will be a deep pond and should be reclaimed for recreational or wildlife management.

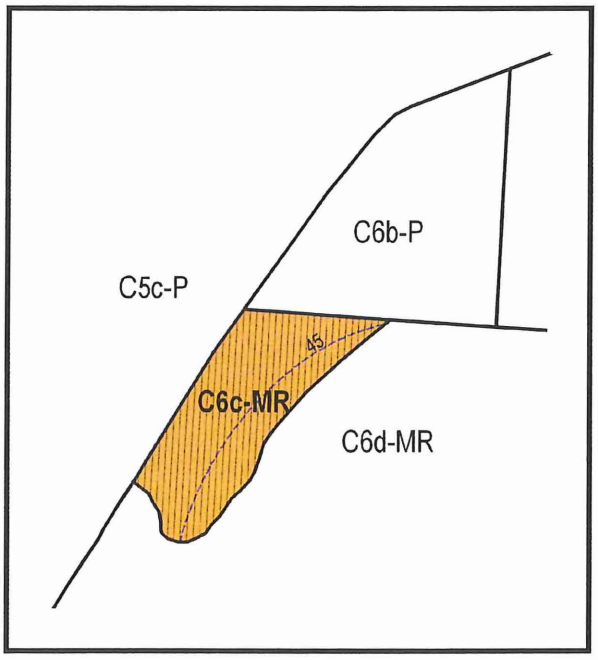


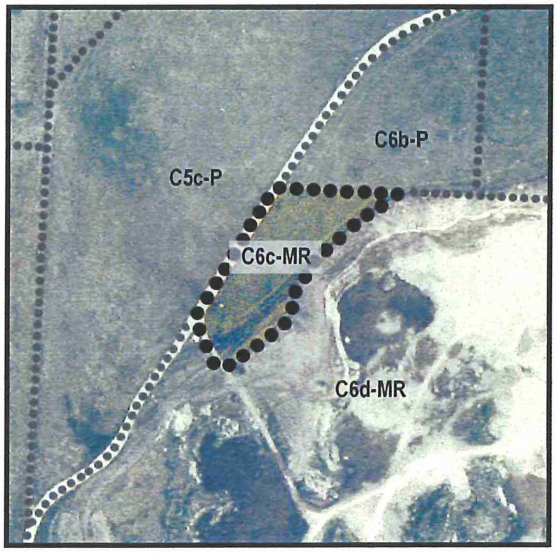
C6c-MR: Mine and Reclaim, Clay County (Section 6, Keene Township)

Aggregate Potential:
High, low overburden and good quality

Prairie Habitat Assessment:
High quality mesic prairie and confirmed habitat for the Dakota and Assiniboia skippers; presumably other protected butterfly species utilize the area. Longspurs and godwits have also been observed in the area.

Fen Impacts:
Expansion west of current footprint may reduce head pressure to the south fen especially if mining below the water table.





Dakota Skipper Habitat

Habitat	Acres
Confirmed Good	3.53
Total	3.53

Area Statistics

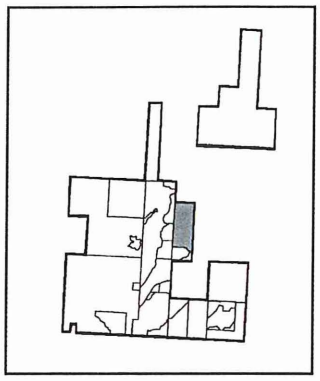
	Landtype	Acres
	Mesic Prairie (Northwest)	3.53
	Total	3.53

Recommendations:
Reclaim with native species as required by the mining plan.

Timeframe:
Approximately half of this area was mined in 2001. Mine the remainder of the area in 2002.

Dotted contours represent the overburden to aggregate thickness ratio. Numbers represent the thickness of aggregate per foot of overburden.

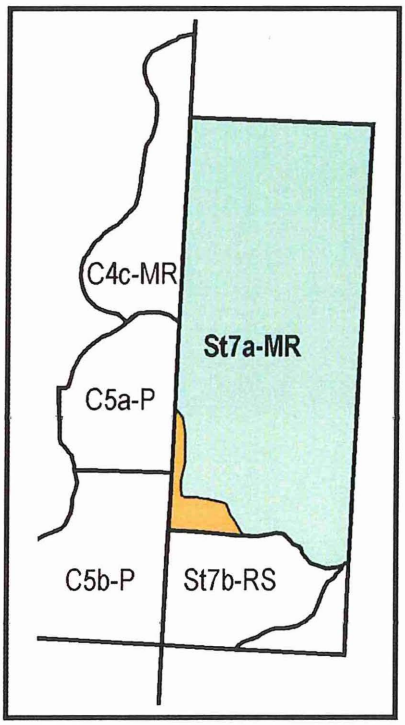
St7a-MR: Mine Footprint and Reclaim, School Trust Fund, (Section 32, Hagen Township)

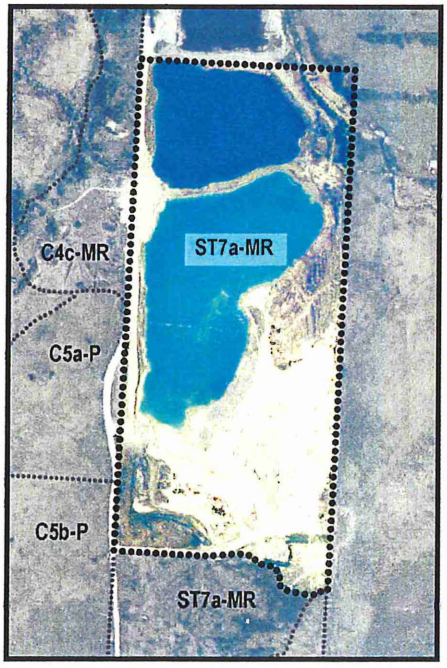


Aggregate Potential:
High but nearly depleted. Berms contain aggregate and should be mined. Stockpile and plant area have a sand lens above high quality gravel. It may not be economically feasible to mine this material.

Prairie Habitat Assessment:
Most of the area is open water or disturbed. Small areas of dry and mesic prairie remain on the north side of the south haul road.

Fen Impacts:
Past mining has reduced head pressure to the north fen which already shows signs of impact. Expanding south could impact both fens by diverting groundwater and further reducing head pressure. Expansion of gravel mining north on private land may also impact groundwater delivery to both fens.



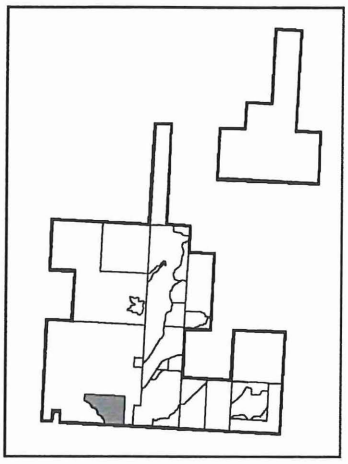


Area Statistics

	Landtype	Acres
	Mesic Prairie (Northwest)	4.11
	Mine Operation	97.40
	Total	101.51

Recommendations:
Continue mining any material still below the water table in the existing footprint. Remove the dike between ponds. Develop a coordinated reclamation plan with the county mine. Reclaim with native species. After reclamation compensate the School Trust Fund for the value of the land and transfer administration to the Felton WMA.

Timeframe:
The current lease with Aggregate Industries expires in 2007. When the aggregate is depleted, the area should be reclaimed and native prairie restored. A proposed mining plan (Walk, 1997) calls for progressive reclamation and redistribution of 270,000 c.y. of spoil to decrease slopes on the east side of the pond. However this material might be used by the county to mix Class 5.

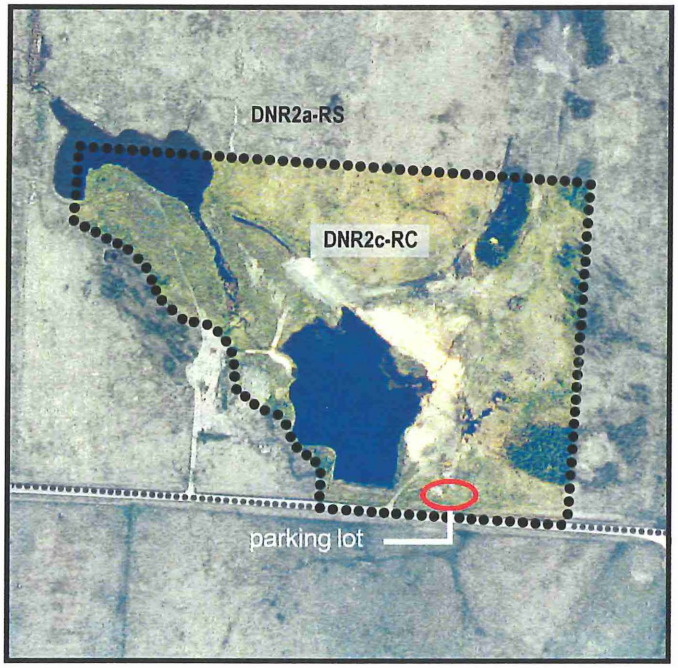


DNR 2c-RC (USFWS easement): Reclaim Depleted Zillmer Pit, DNR, (Section 1, Flowing Township)

Aggregate Potential:
None, shallow beach ridge deposits of poor quality

Prairie Habitat Assessment:
Small area of wet prairie on north side. Most of the area is disturbed and needs restoration.

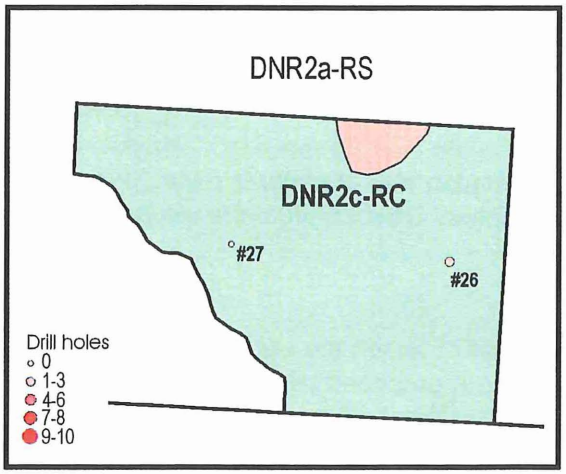
Recommendations:
Reclaim spoil piles and smooth slopes around pond where necessary for reseeding. Restore mesic and dry prairie vegetation. Continue reclamation work started by the stewardship committee.



Habitat Management:
Mow 2-3 times annually the first 3 years of establishment. Maintain with prescribed burning.

Interpretive Site:
A parking lot and interpretive signs have been developed for public access and education. Native grasses should be restored along the perimeter of the parking area and a more detailed planting scheme featuring native plants should be developed and installed at the interior island. The parking lot should be monitored on a regular basis by the DNR.

Timeframe:
The grading concluded 6/2001. Seeding will take place spring of 2002.



Area Statistics

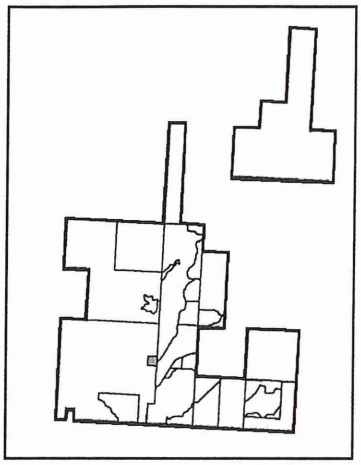
	Landtype	Acres
	Grasslands, Bare Ground, Water	54.28
	Wet Prairie (Northwest)	2.02
	Total	56.30

Drillhole Statistics

Drillhole	Gravel Thickness	Gravel Above Fen	Aggregate Ratio	Quality
26	6	NA	0.67	3.0
27	0	NA	0.00	0.0

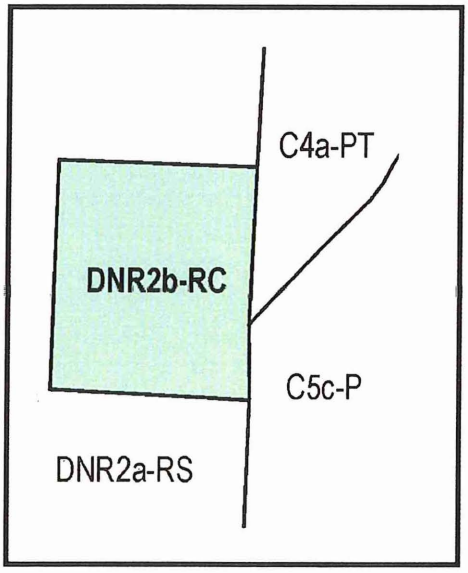
Drillhole symbols are scaled and colored to represent the committee's estimate of the deposit quality. Quality increases with circle size and saturation.

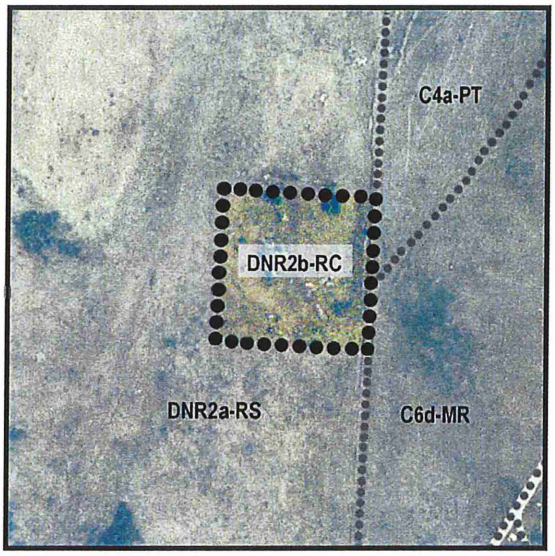
DNR 2b-RC (USFWS easement): Reclaim Spoil Piles, DNR (Section 1, Flowing Township)



Aggregate Potential:
Shallow beach ridge deposit that may have been depleted.

Prairie Habitat Assessment:
None evident but it borders important skipper habitat





Area Statistics

	Landtype	Acres
	Grasslands	5.22
	Total	5.22

Recommendations:
Aggregate Industries has agreed to level some spoil piles. Then the area should be restored to native prairie vegetation.

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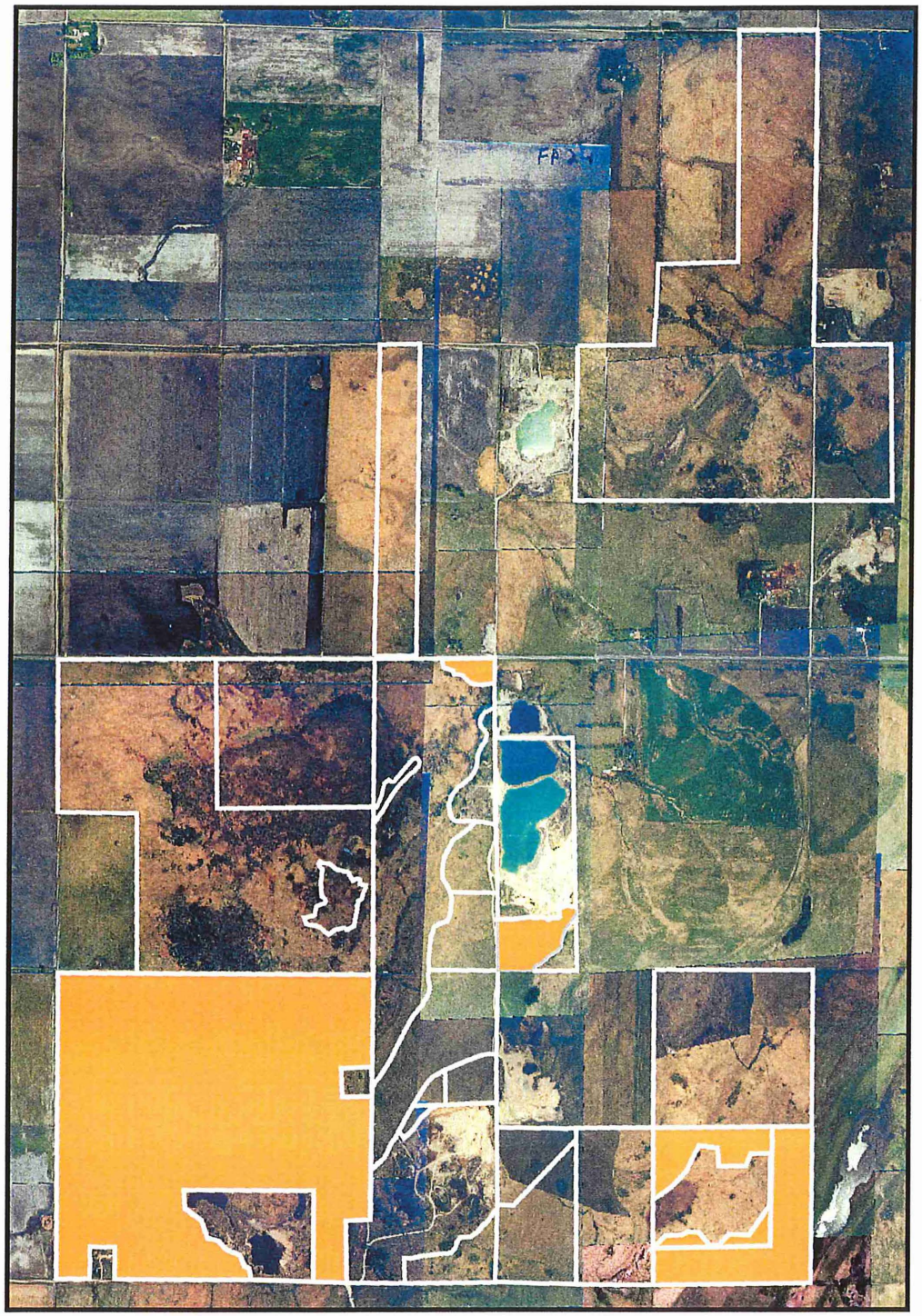
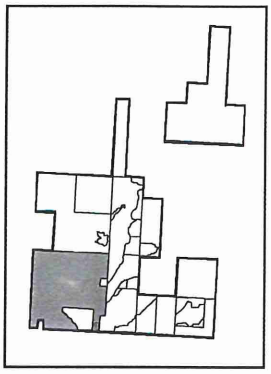


RESTORE



DNR 2a-RS (USFWS easement): Restore, DNR, (Section 1, Flowing Township)

Aggregate Potential:
Slight to none, shallow deposit of low quality material

Prairie Habitat Assessment:
Most of the area is disturbed except for areas of wet prairie and a small portion of shrub swamp on the north border. Leafy spurge, Canada thistle, and woody species have invaded the site and need to be controlled.

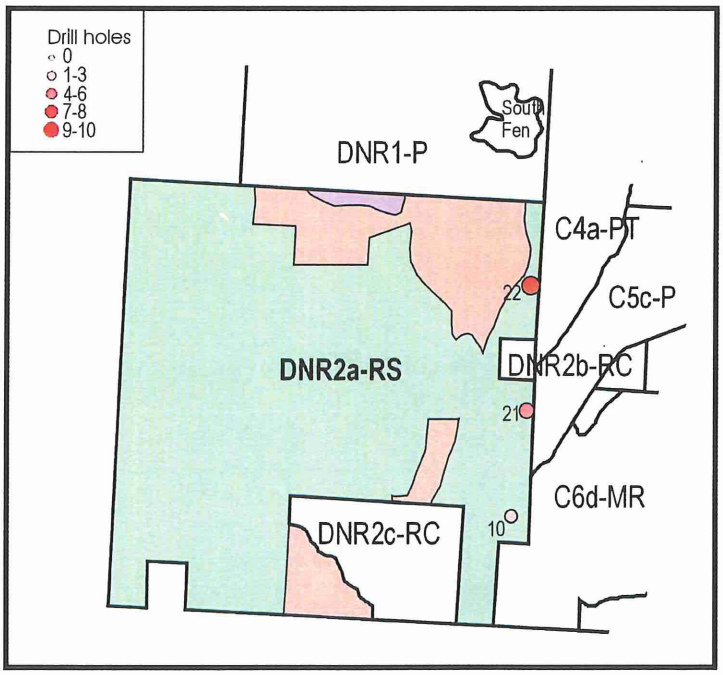
Fen Impacts:
None known.

Drillhole Statistics

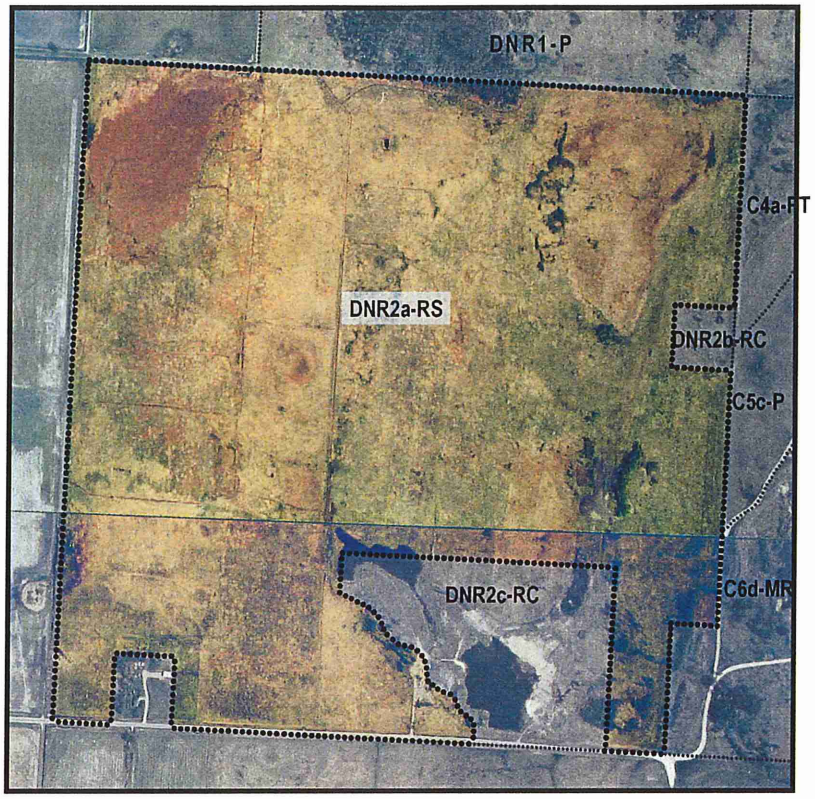
Drillhole	Gravel Thickness	Gravel Above Fen	Aggregate Ratio	Quality
10	9	NA	1.29	2.0
21	16	NA	16.00	5.0
22	11	NA	5.50	7.0

Area Statistics

	Landtype	Acres
	Agricultural Land, Grasslands	459.52
	Shrub Swamp Seepage Subtype	5.17
	Wet Prairie (Northwest)	99.49
	Total	564.18



Drillhole symbols are scaled and colored to represent the committee's estimate of the deposit quality. Quality increases with circle size and saturation.

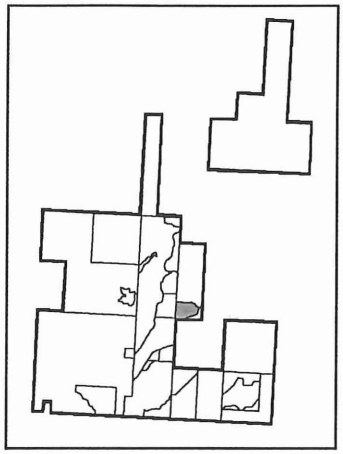


Recommendations:

Prairie should be reconstructed in this area as soon as possible and will require mowing 2-3 times annually for the first 3 years. Burning may be necessary for seedbed preparation. The adapted community transitions from dry-mesic prairie on the east boundary to wet prairie or marsh on the west. Once established it could serve as a corridor to dry and mesic prairie to the south.

Habitat Management:

After establishment, maintain prairie by mowing or prescribed burning.
Cut/girdle undesirable woody species.
Control leafy spurge and Canada thistle with biological or chemical means.

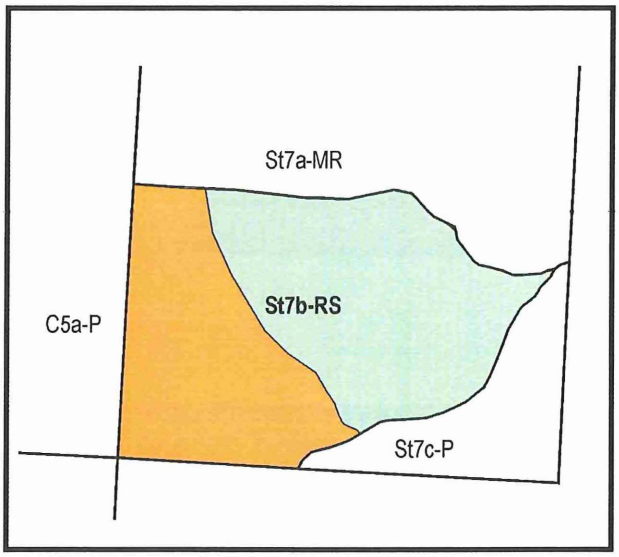


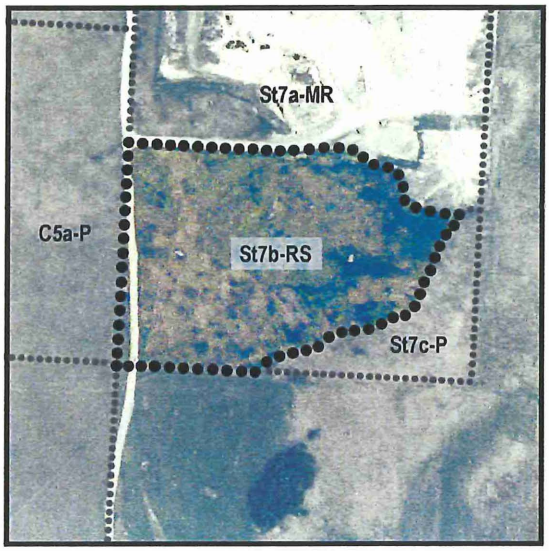
St7b-RS: Restore, DNR-State Trust Fund, (Section 32, Hagen Township)

Aggregate Potential:
Not economically viable at the present time, upper deposit is sand.

Prairie Habitat Assessment:
Currently disturbed with some mesic prairie, borders high quality habitat to the west. Woody encroachment and exotic species are present.

Fen Impacts:
Head pressure would likely be lost to both the north and south fen if this area is mined within the water table buffer.





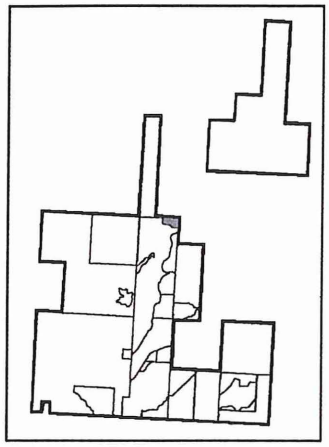
Area Statistics

	Landtype	Acres
	Grasslands	11.53
	Mesic Prairie (Northwest)	9.20
	Total	20.73

Recommendations:
Since there is little economic value to this deposit and it borders important habitat, it should be restored to prairie and transferred to the WMA after compensation to the School Trust. Success of the restoration should be assessed after two prescribed burns.

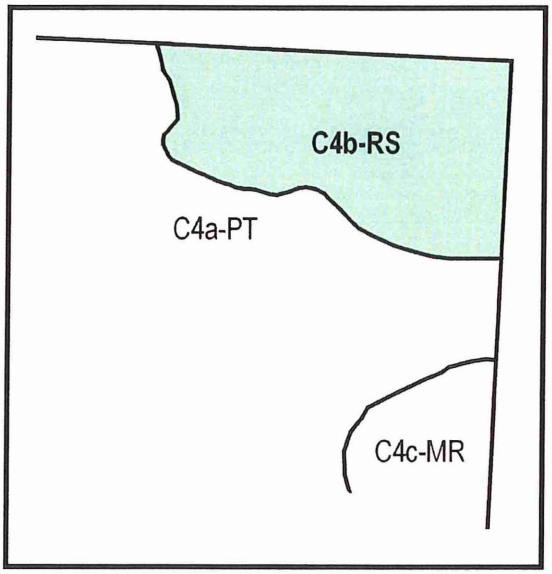
Habitat Management:
Maintain restored prairie with prescribed burning or hay mowing. Cut or girdle woody vegetation. Control exotic species by biological or chemical means.

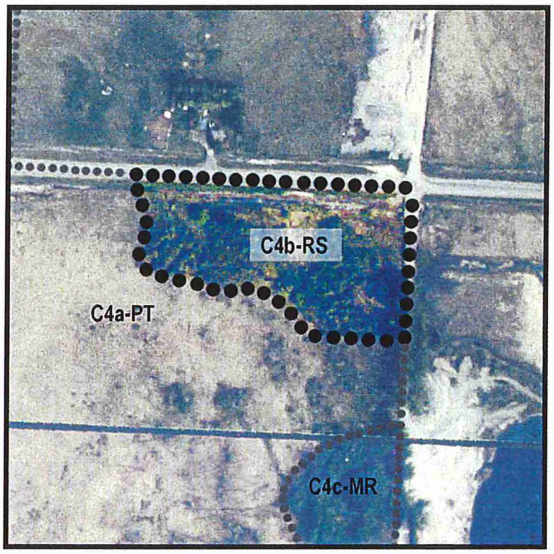
C4b-RS: Restore, Clay County (Section 31, Hagen Township)



Aggregate Potential:
None documented.

Prairie Habitat Assessment:
This area has been disturbed by past mining activities. It should be restored using native vegetation.



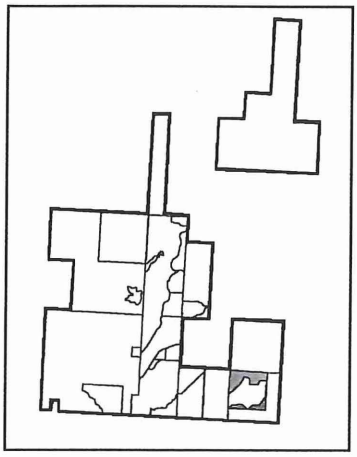


Area Statistics

	Landtype	Acres
	Grasslands	8.05
	Total	8.05

Recommendations:
Explore permanent preservation in conjunction with C4a or after restoration. Preservation options include easement, sale, or long-term lease agreement with a conservation organization like The Nature Conservancy or DNR.

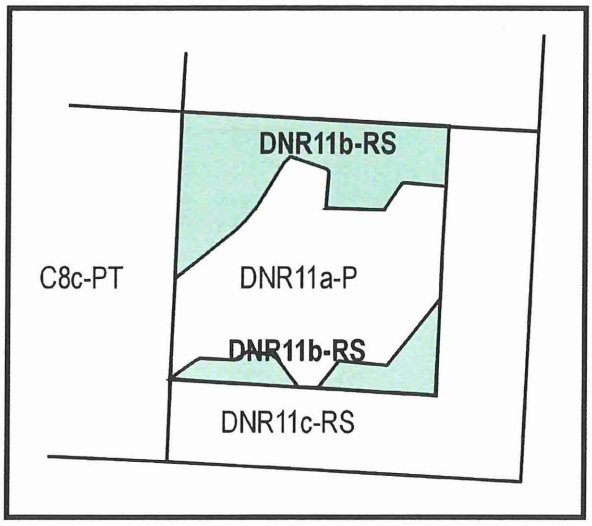
Habitat Management:
Maintain prairie with prescribed burning. Remove trees by girdling or cutting.



DNR11b-RS: Restore, DNR, Shaw Addition (SE ¼, Section 5, Keene Township)

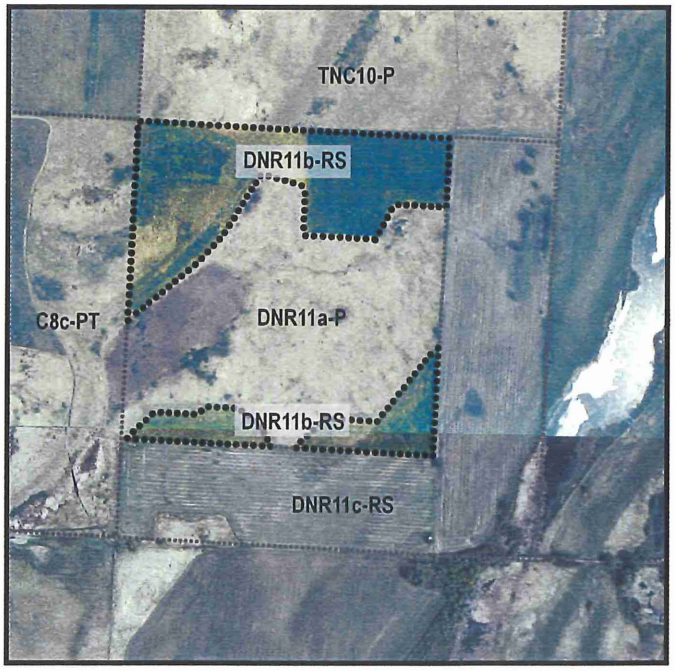
Aggregate Potential:
None documented

Prairie Habitat Assessment:
This area was farmed prior to DNR acquisition. Restoration efforts began in 2001.



Area Statistics

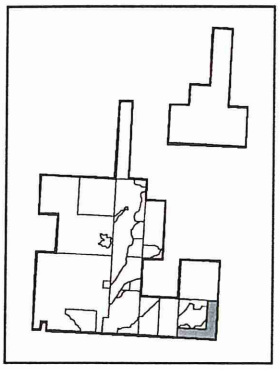
	Landtype	Acres
	Agricultural Lands, Grasslands	39.74
	Total	39.74



Recommendations:
Restore native prairie with seed from local genotypes (collected from nearby native prairies).

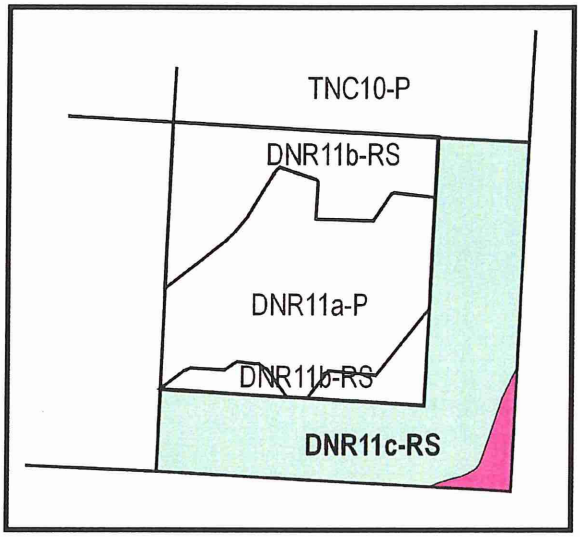
Habitat Management:
Maintain restored prairie with fire or haying.
Control exotic species by biological or chemical means.

DNR11c-RS: Restore, DNR, Shaw Addition, (SE ¼, Section 5, Keene Township)



Aggregate Potential: None documented.

Prairie Habitat Assessment:
Area was farmed prior to DNR acquisition. A mixed emergent marsh is located in the southeast corner.

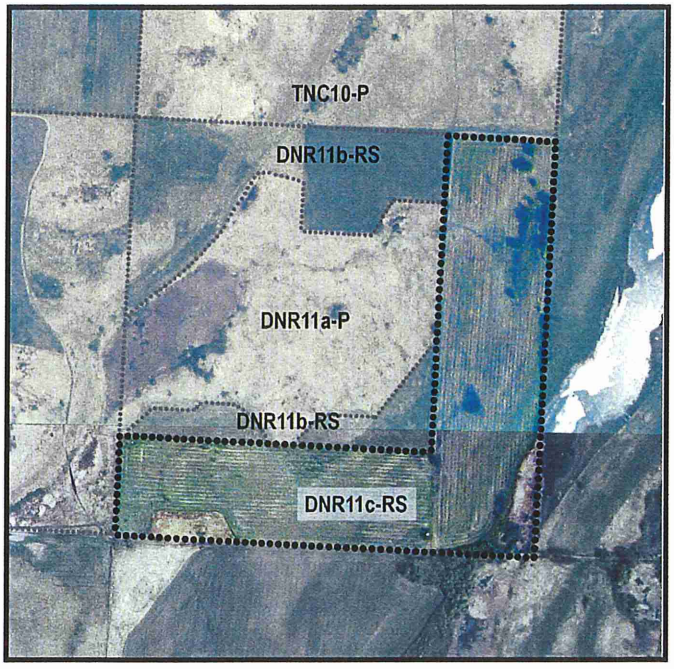


Area Statistics

	Landtype	Acres
	Agricultural Lands, Grasslands	65.87
	Mixed Emergent Marsh (Prairie)	4.03
	Total	69.90

Recommendations:
The area should be restored to native prairie using seed from local genotypes (collected from local native prairies).

Habitat Management:
Once the prairie is restored it should be maintained by mowing hay or prescribed burning.



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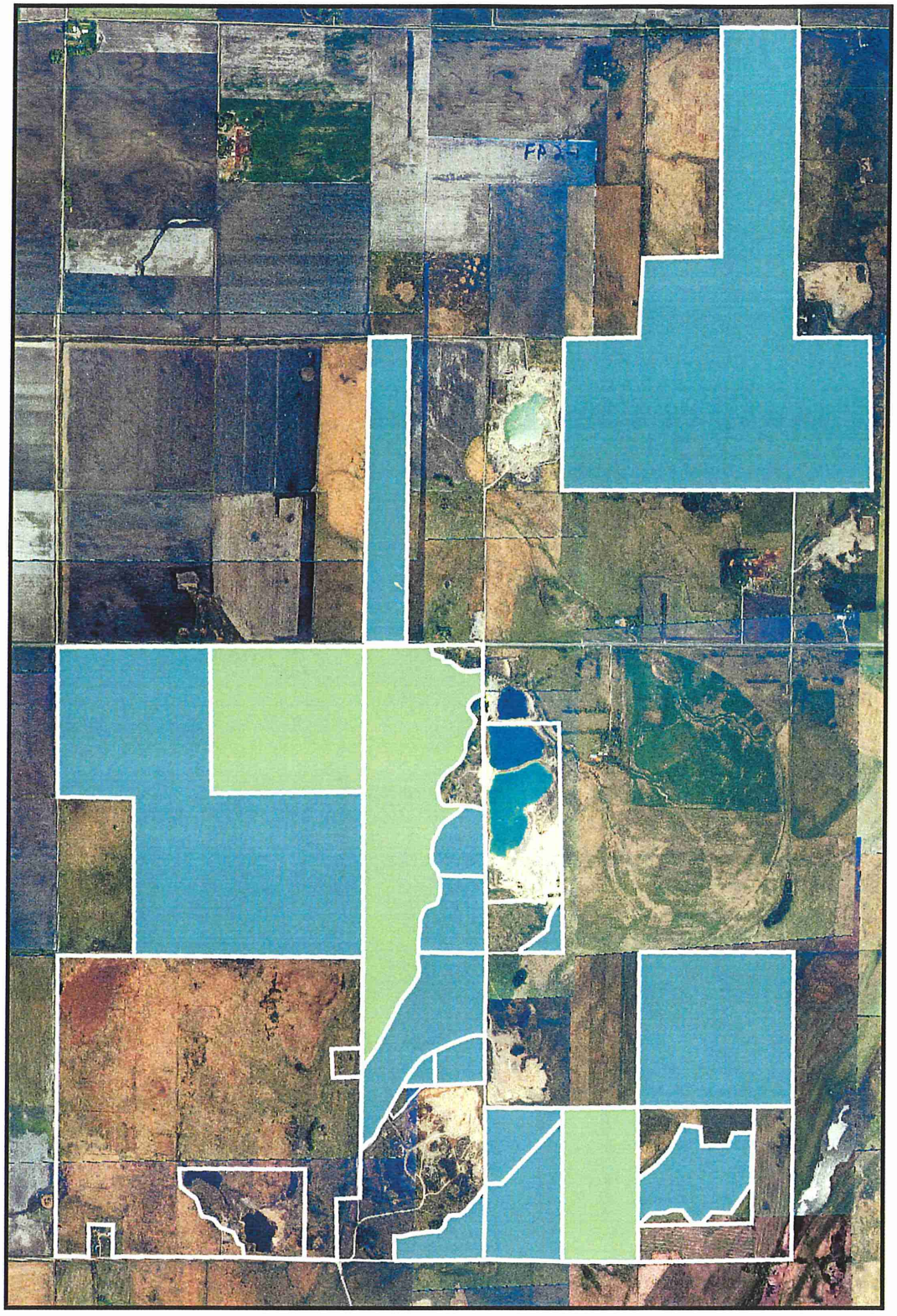
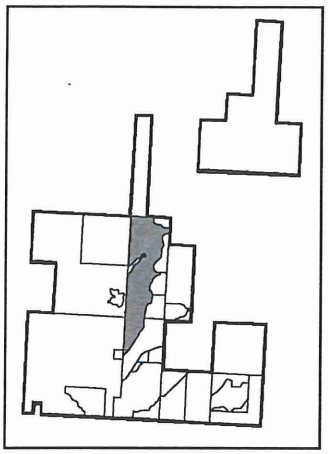
PRESERVE / TRANSFER



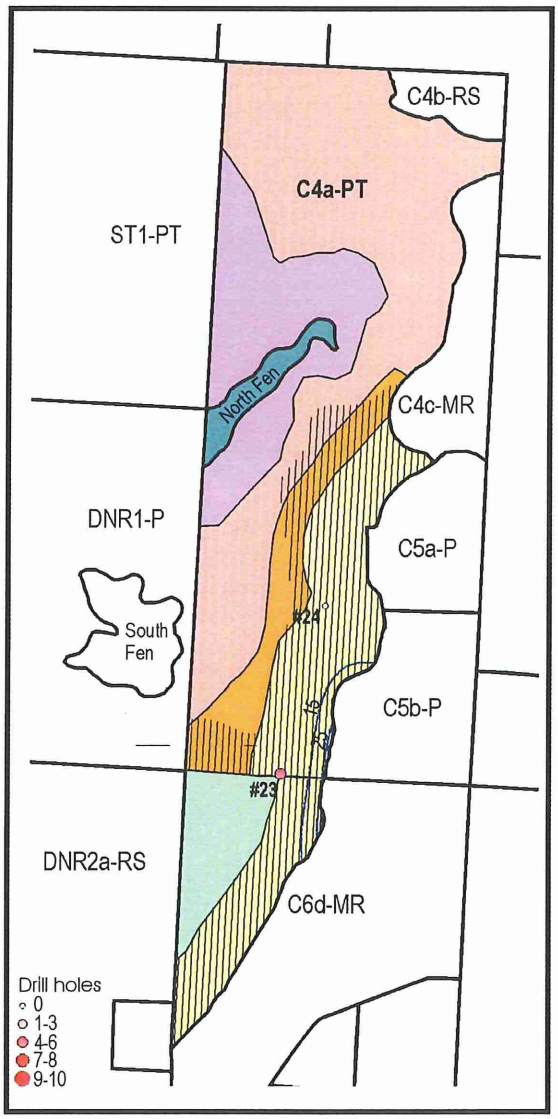


C4a-PT: Preserve or Transfer, Clay County, (Section 31, Hagen Township, & Section 6, Keene Township)

Aggregate Potential:
Along the southeast boundary aggregate samples indicate average quality and high overburden.

Prairie Habitat Assessment:
Diverse gradation from wet to dry habitats. Documented rare plants and butterfly habitat with severe woody encroachment.

Fen Impacts:
The north fen is located in this parcel. Mining below the water table buffer would impact this and the south fen that borders this parcel.



Area Statistics

	Landtype	Acres
	Grassland	14.03
	Dry Prairie (Northwest) Sand-Gravel Subtype	50.37
	Mesic Prairie (Northwest)	19.93
	Shrub Swamp Seepage Subtype	37.69
	Wet Prairie (Northwest)	89.08
	North Fen	5.62
	Total	216.72

Dakota Skipper Habitat

Habitat	Acres
Confirmed Good	66.79
Total	66.79

Drillhole Statistics

Drillhole	Gravel Thickness	Gravel Above Fen	Aggregate Ratio	Quality
23	42	NA	4.20	5.0
24	0	NA	0.00	0.0

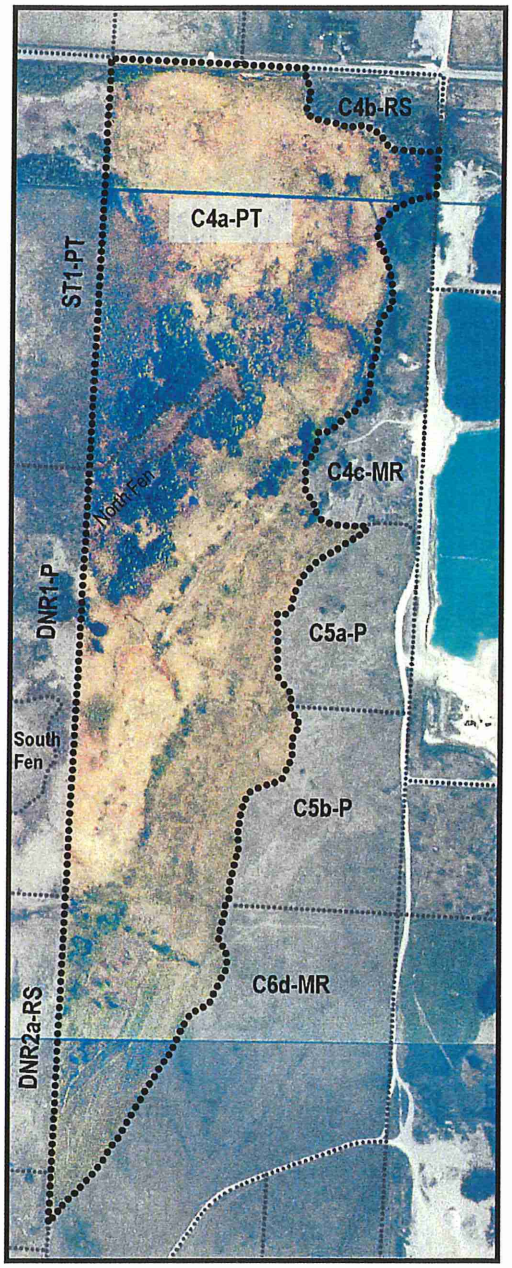
Drillhole symbols are scaled and colored to represent the committee's estimate of the deposit quality. Quality increases with circle size and saturation.

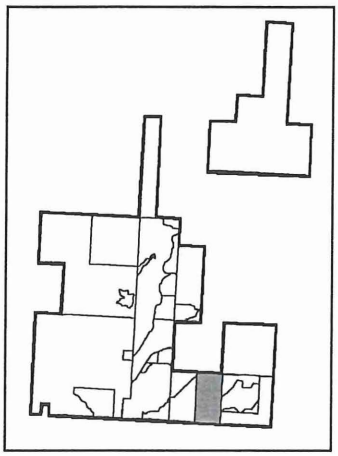
Dotted contours represent the overburden to aggregate thickness ratio. Numbers represent the thickness of aggregate per foot of overburden.

Recommendations:
This area offers little aggregate value to the county but high habitat complexity and fragility. Preserve permanently through easement, sale, transfer, or other protection agreement to a conservation entity like DNR or The Nature Conservancy.

Habitat Management:
Maintain and enhance prairie by prescribed burning or haying. Remove woody vegetation by girdling, cutting, and prescribed burning. Continue to monitor the fen.

Timeframe:
The county should explore options to transfer this land for the purchase of Class 5 or property where this material can be mined in the immediate future.

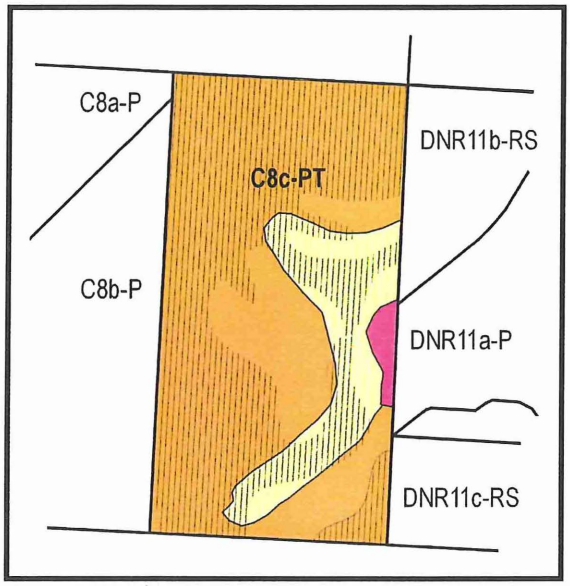


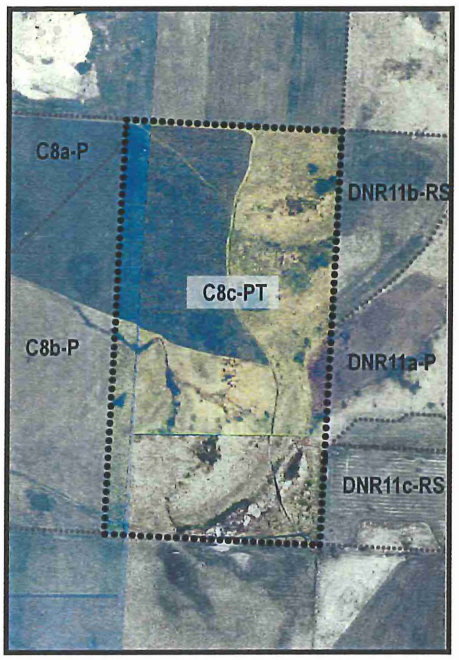


C(DNR) 8c-P: Preserve, Clay County Bicentennial Prairie lease to DNR (Section 5, Keene Township)

Aggregate Potential:
None documented

Prairie Habitat Assessment:
High quality prairie and habitat for rare species with some woody encroachment.





Area Statistics

	Landtype	Acres
	Dry Prairie (Northwest) Sand-Gravel Subtype	15.77
	Mesic Prairie (Northwest)	65.16
	Mixed Emergent Marsh (Prairie	1.53
	Total	82.46

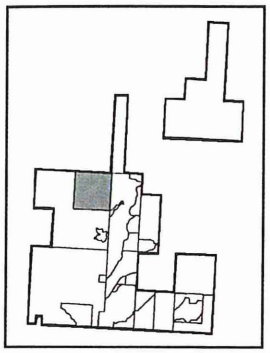
Dakota Skipper Habitat

Habitat	Acres
Confirmed Good	53.96
Total	53.96

Recommendations:
Area is currently leased to DNR as a state scientific and natural area through 2026. Preserve through permanent easement, transfer, sale, or other protection agreement.

Habitat Management: Control woody species and maintain prairie with prescribed burning. Gate and restrict access at the southeast corner.

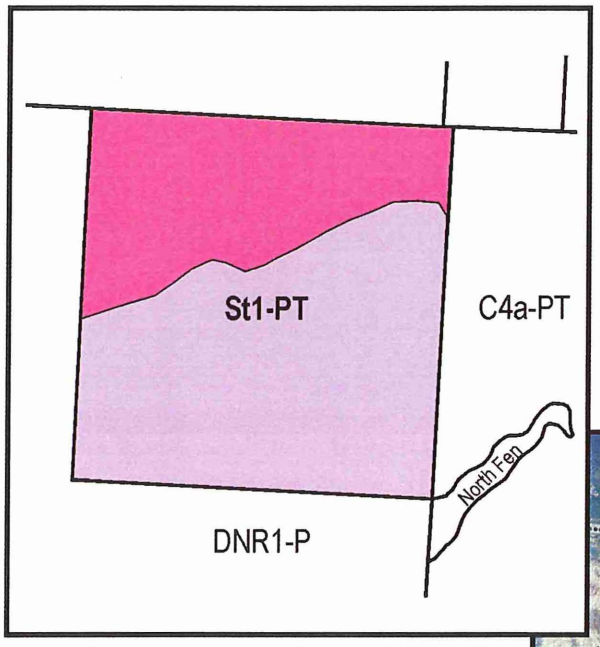
St1-PT: Preserve or Transfer to WMA, DNR State Trust Fund, (NW1/4 section 36, Felton Township)



Aggregate Potential: None documented.

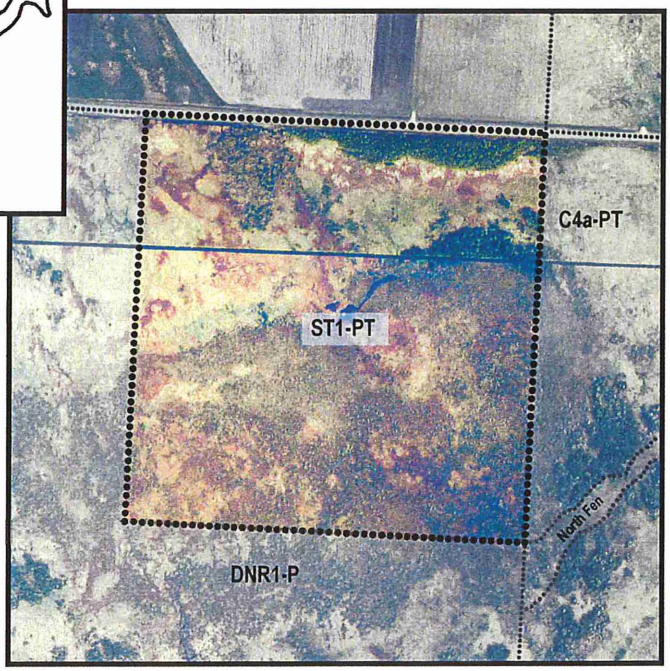
Prairie Habitat Assessment:
High quality prairie marsh and shrub swamp but experiencing significant woody encroachment.

Fen Impact: Proximate to north fen



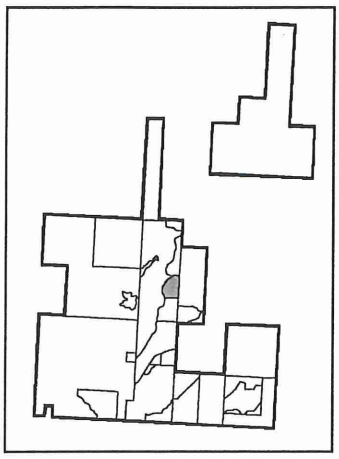
Area Statistics

	Landtype	Acres
	Mixed Emergent Marsh (Prairie)	56.36
	Shrub Swamp Seepage Subtype	97.26
	Total	153.62



Recommendations:
Parcel borders Felton WMA, transfer to that unit after reimbursing the State School Trust Fund.

Habitat Management:
Habitat: Prescribed burning is needed to maintain prairie condition. Undesirable woody species should be girdled or removed.

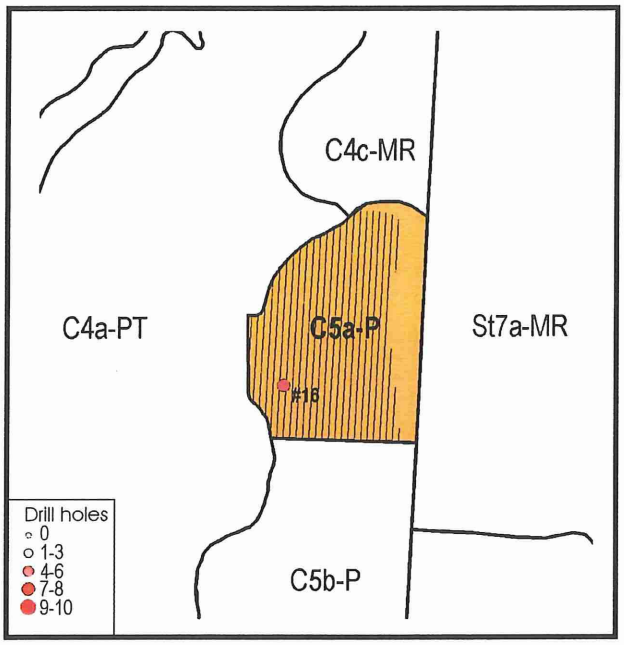


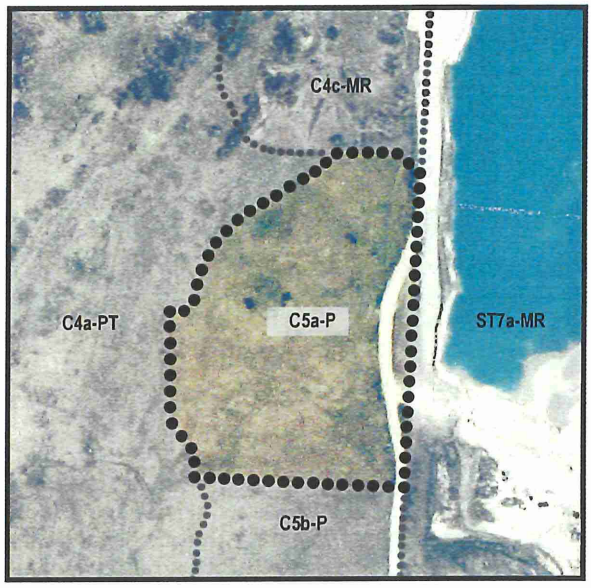
C5a-P: Preserve, Clay County, (Section 31, Hagen Township)

Aggregate Potential:
Deep overburden reduces the desirability of this high quality deposit.

Prairie Habitat Assessment:
High quality mesic prairie and butterfly habitat with scattered woody encroachment.

Fen Impacts:
Mining below the water table buffer would cause impacts to both fens by diverting ground water.





Drillhole Statistics

Drillhole	Gravel Thickness	Gravel Above Fen	Aggregate Ratio	Quality
16	45	-3.92	2.25	8.0

Area Statistics

	Landtype	Acres
	Mesic Prairie (Northwest)	20.70
	Total	20.70

Dakota Skipper Habitat

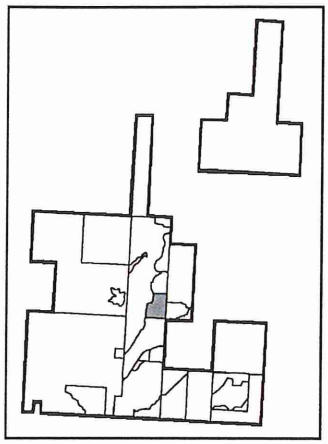
Habitat	Acres
Confirmed Good	15.66
Total	15.66

Recommendations:
Mining the aggregate is not economically feasible in the current and foreseeable future. Habitat and fen impacts would be severe. The area should be preserved through a 75 year lease, easement, other protection agreement, or sale.

Habitat Management: Maintain prairie with prescribed burning or mowing hay. Eliminate woody encroachment by girdling or cutting.

Timeframe:
It is unlikely that this area will be mined because the overburden is 20' in drill hole #16. Very little gravel would be available above the water table buffer, given the proximity of this parcel to the fens. The status of this should be reassessed in 75 years.

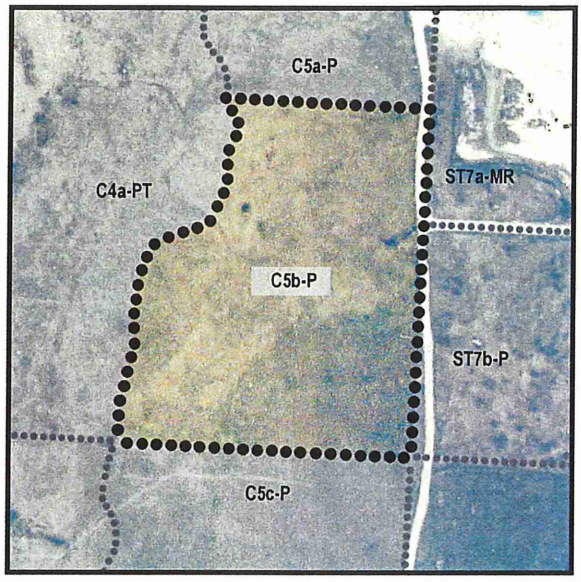
C5b-P: Preserve, Clay County, (Section 31, Hagen Township)

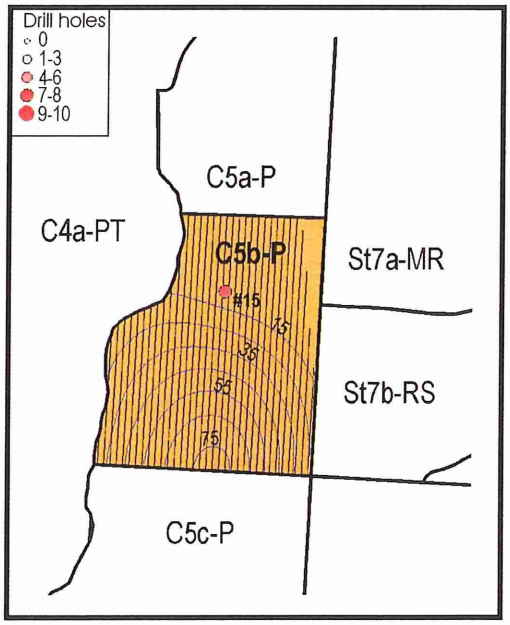


Aggregate Potential:
High quality and quantity gravel found in drill samples south of parcel. Overburden increases significantly to the north and quality diminishes.

Prairie Habitat Assessment:
High quality mesic prairie utilized by endangered species.

Fen Impacts:
Mining below the ground water buffer would cause severe impacts to south fen due to alteration of groundwater regime.





Drillhole Statistics

Drillhole	Gravel Thickness	Gravel Above Fen	Aggregate Ratio	Quality
15	72	-4.59	3.79	8.0

Dakota Skipper Habitat

Habitat	Acres
Confirmed Good	26.70
Total	26.70

Area Statistics

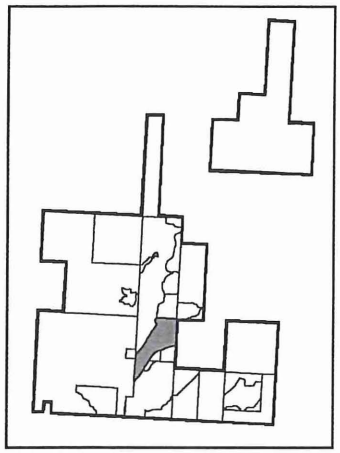
	Landtype	Acres
	Mesic Prairie (Northwest)	27.64
	Total	27.64

Recommendations:
Severe impacts would result from disruption of this area. The gravel resource is not economically feasible to mine in the current market because of overburden depth although its quality is high. This is a high conflict area. In order to maintain habitat, prevent fragmentation, and maintain ground water delivery to the south fen, a lease, easement, or other protection agreement should be established for a minimum of 75 years. Or, the county could sell this parcel and secure alternate supplies of road gravel.

Habitat Management: Maintain prairie through prescribed burning or haying.

Timeframe:
This area should be preserved and managed for prairie by lease or easement for 75 years if the county maintains ownership. The status of this should be reassessed in 75 years.

Preserve

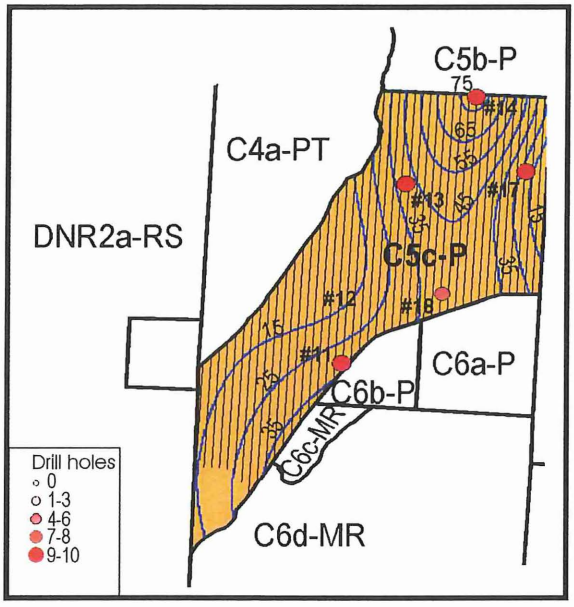


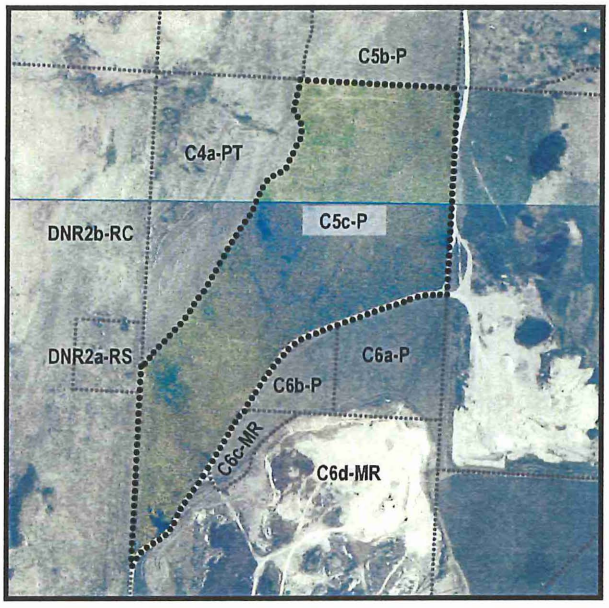
C5c-P: Preserve, Clay County, (Section 6, Keene Township)

Aggregate Potential:
High quality and quantity resource based on industry interpretation of data.

Prairie Habitat Assessment:
High quality mesic prairie utilized by rare species, including endangered butterflies.

Fen Impact:
Mining within the water table buffer of this area would cause severe groundwater disruption to the south fen.





Drillhole Statistics

Drillhole	Gravel Thickness	Gravel Above Fen	Aggregate Ratio	Quality
11	68	9.26	34.00	10.0
12	61	-5.79	4.07	7.0
13	83	9.05	41.50	9.0
14	77	18.32	77.00	10.0
17	64	0.19	3.37	10.0
18	82	13.94	41.00	8.0

Area Statistics

	Landtype	Acres
	Mesic Prairie (Northwest)	73.38
	Total	73.38

Dakota Skipper Habitat

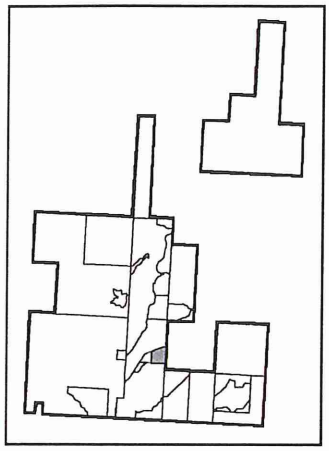
Habitat	Acres
Confirmed Good	71.00
Total	71.00

Recommendations: This is a high conflict area of good gravel and critical habitat. In order to maintain habitat, prevent fragmentation, and maintain ground water delivery to the south fen, a lease, easement, or other protection agreement should be established for a minimum of 60 years. Or, the county could sell this parcel and secure alternate supplies of road gravel.

Habitat Management: Maintain prairie through prescribed burning or haying.

Timeframe: This area should be preserved and managed for prairie until the county pit is near depletion in 60 years. At that time the county's needs should be reassessed.

Preserve

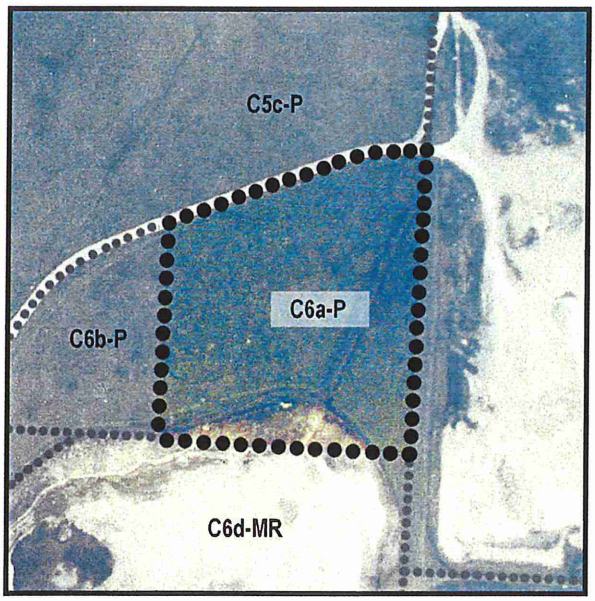


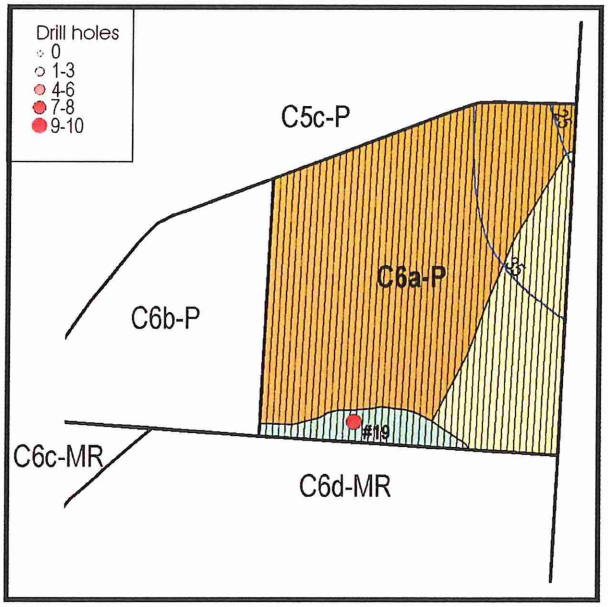
C6a-P: Preserve, Clay County, (Section 6, Keene Township)

Aggregate Potential:
Good quality and quantity

Prairie Habitat Assessment:
High quality dry and mesic prairie; critical habitat for prairie vole and skippers. Forms critical corridor for wildlife between land north of the county pit and Bicentennial Prairie SNA. Other rare species have been sighted in this area.

Fen Impact: Mining below the watertable buffer would divert regional flow of groundwater to the south fen.





Recommendations:
This area provides a link between butterfly habitat north of the county mine and Bicentennial Prairie SNA. It also provides habitat for other rare species and should be preserved by lease, easement, or other protective agreement for a minimum of 35 years.
Access: Limit the haul road width to its current alignment and dimension.
Habitat management: Maintain and enhance prairie by prescribed burning or mowing.

Timeframe: This area should be preserved for 35 years. The county will better understand the availability of road gravel from the private market and the lease value of the county mine.

Area Statistics

	Landtype	Acres
	Dry Prairie (Northwest) Sand-Gravel Subtype	3.26
	Mesic Prairie (Northwest)	9.92
	Mine Operation	0.75
	Total	13.93

Drillhole Statistics

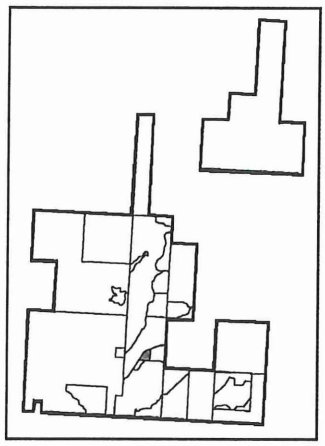
Drillhole	Gravel Thickness	Gravel Above Fen	Aggregate Ratio	Quality
19	77	NA	38.50	9.0

Dakota Skipper Habitat

Habitat	Acres
Confirmed Good	13.18
Total	13.18

Numbers on dotted contours represent the thickness of aggregate per foot of overburden.

Drillhole symbols represent the committee's estimate of the deposit quality. Quality increases with circle size and saturation.

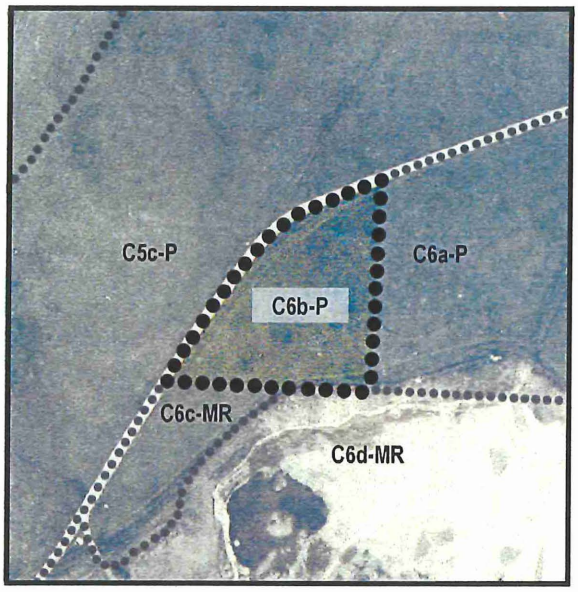


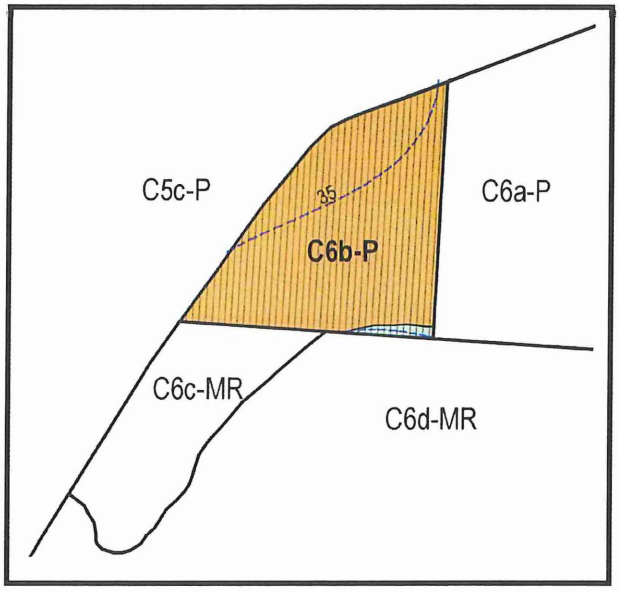
C6b-P: Preserve, Clay County, (Section 6, Keene Township)

Aggregate Potential:
Presumably high quality and quantity. Borders the existing county mine. Low overburden and deep deposit of high quality aggregate.

Prairie Habitat Assessment: High quality dry prairie and rare species habitat.

Fen Impacts: Mining below the water table buffer would divert regional flow of ground water to the south fen causing loss of head pressure and decreased quantity of water to wetland.





Recommendations:
This area should be preserved because mining would severely fragment prairie habitat and impact the south fen. Preservation through a lease, easement, or other protection agreement should run a minimum of 35 years.
Access: Limit haul road to current alignment and width.
Habitat Management:
Mow hay or burn to maintain prairie.

Area Statistics

	Landtype	Acres
	Mesic Prairie (Northwest)	5.89
	Mine Operation	0.12
	Total	6.01

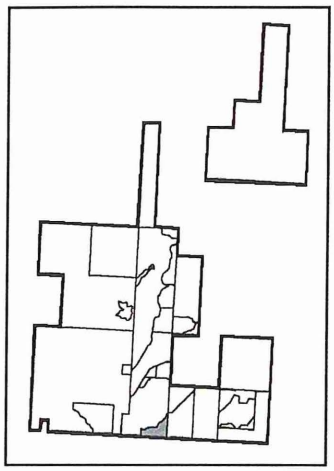
Dakota Skipper Habitat

Habitat	Acres
Confirmed Good	5.89
Total	5.89

Dotted contours represent the overburden to aggregate thickness ratio. Numbers represent the thickness of aggregate per foot of overburden.

Timeframe:
This area should be preserved through a lease, easement, or other protection agreement for 35 years. The county should reassess status at that time based on the availability of road gravel from the private market, the projected life of county supply, and lease value of the county mine.

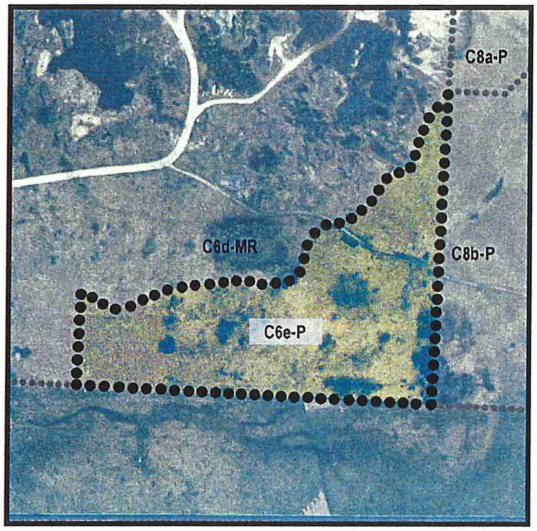
C6e-P: Preserve Clay County, (Section 6, Keene township)



Aggregate Potential:
Exhibits increasing potential from none in southeast corner to good moving north and west. Quantity may diminish towards existing northwest boundary because drill hole 9 contained no gravel but this material could be used for mixing Class 5 for county road use.

Prairie Habitat Assessment:
Southeast corner exhibits high quality prairie and no aggregate potential. Scattered woody species and leafy spurge are present.

Fen Impacts: None



Drillhole Statistics

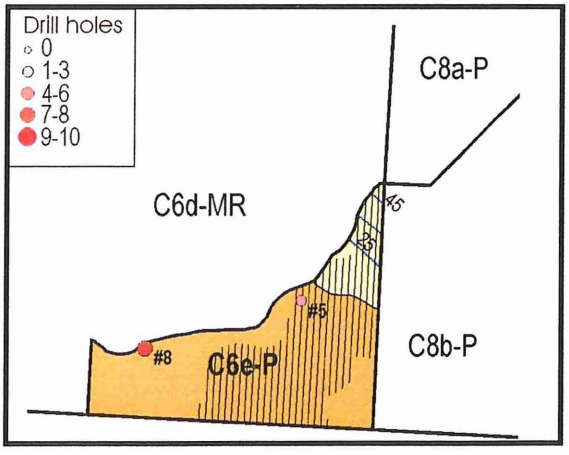
Drillhole	Gravel Thickness	Gravel Above Fen	Aggregate Ratio	Quality
5	57	NA	0.00	6.0
8	54	NA	1.15	10.0

Area Statistics

	Landtype	Acres
	Dry Prairie (Northwest) Sand-Gravel Subtype	2.52
	Mesic Prairie (Northwest)	16.74
	Total	19.26

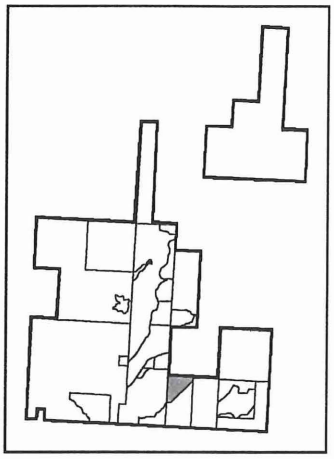
Dakota Skipper Habitat

Habitat	Acres
Confirmed Good	10.01
Total	10.01



Dotted contours represent the overburden to aggregate thickness ratio. Numbers represent the thickness of aggregate per foot of overburden.
Drillhole symbols are scaled and colored to represent the committee's estimate of the deposit quality. Quality increases with circle size and saturation.

Recommendations:
If the county needs this parcel for mining and applies for a takings permit, DNR has agreed that the Felton Prairie Stewardship Plan and its recommendations will satisfy mitigation needs.
Habitat Management: Preserve prairie south and east until needed for spoil or stockpiling. If prairie is disturbed, mitigate. Control leafy spurge with biological or chemical means.
Remove woody vegetation by girdling or cutting. Maintain prairie with prescribed burning or mowing hay.
Access: Improve directional signs leading to Bicentennial Prairie SNA and parking area.
Timeframe:
This area should be preserved until 2018 when it may be needed for aggregate plant and stockpiles associated with the current county gravel mine.

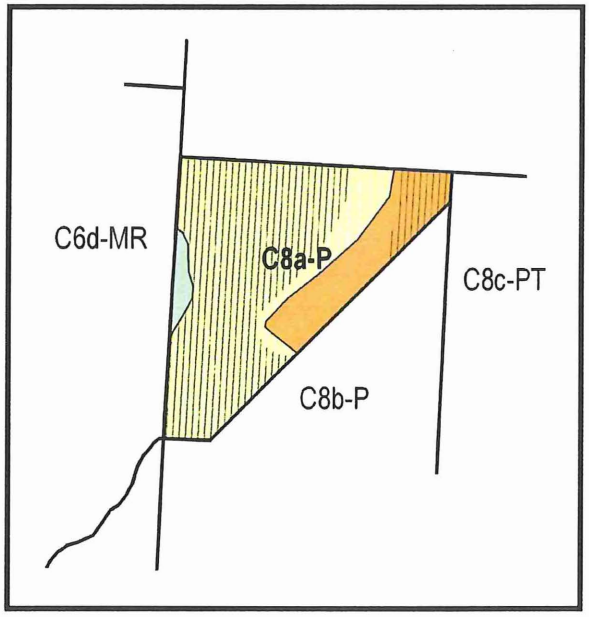


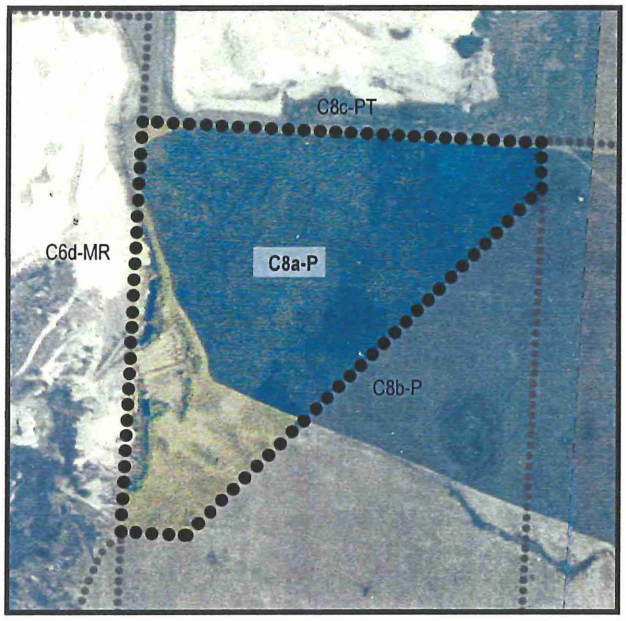
C(DNR)8a-P: Preserve, Clay County Bicentennial Prairie lease to DNR, (Section 5, Keene Township)

Aggregate Potential:
Resistivity survey in 2000 indicated a significant aggregate resource of undetermined quality.

Prairie Habitat Assessment:
Area supports critical habitat for endangered species and adjoins narrow corridor on county land east of the gravel mine connecting Bicentennial Prairie SNA with prairie habitat north of the county mine.

Fen Impacts:
Mining below the water table buffer (10') would divert ground water delivery to the south fen and decrease head pressure.





Area Statistics

	Landtype	Acres
	Open Ground	0.82
	Dry Prairie (Northwest) Sand-Gravel Subtype	21.25
	Mesic Prairie (Northwest)	5.99
	Total	28.06

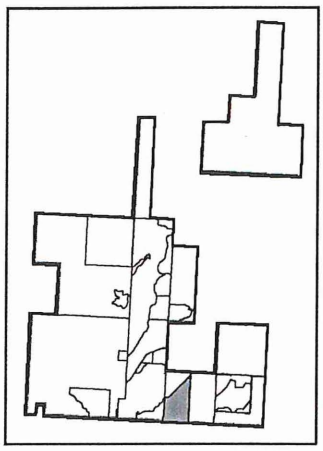
Dakota Skipper Habitat

Habitat	Acres
Confirmed Good	18.05
Total	18.05

Recommendations:
This area should be preserved through easement, lease, or other protective agreement for a minimum of 60 years because it serves as a critical habitat corridor. Access should be restricted at the northwest corner with a gate or boulders.
Habitat Management: Prescribed burning

Timeframe:
This area is currently leased to DNR as a Scientific and Natural Area through 2006.

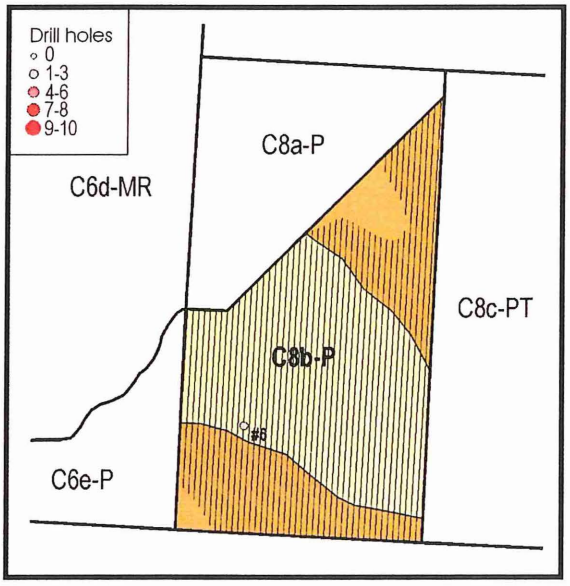
C(DNR)8b-P: Preserve, Clay County Bicentennial Prairie lease to DNR (Section 5, Keene Township)

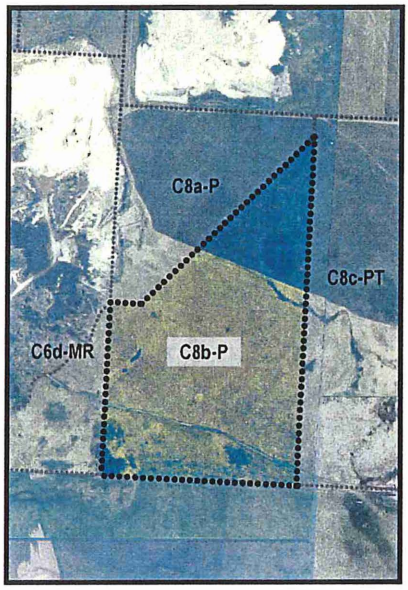


Aggregate Potential:
None documented in drill hole #6, but resistivity survey indicated a mixed deposit of sand and gravel with high overburden. Committee assumes the quality would be poor.

Prairie Habitat Assessment:
High quality prairie and habitat for rare species with woody encroachment (Cottonwood clones) on spoil piles.

Fen Impacts:
Not evaluated because aggregate resource is not desirable.





Drillhole Statistics

Drillhole	Gravel Thickness	Gravel Above Fen	Aggregate Ratio	Quality
6	0	NA	0.00	2.0

Area Statistics

	Landtype	Acres
	Dry Prairie (Northwest) Sand-Gravel Subtype	32.30
	Mesic Prairie (Northwest)	23.75
	Total	56.05

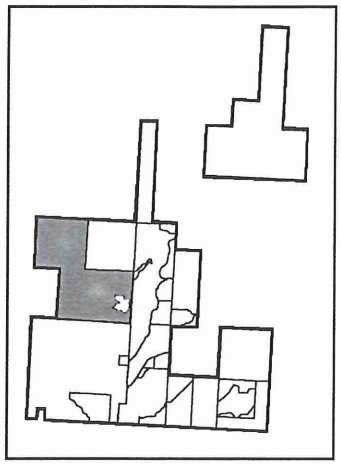
Dakota Skipper Habitat

Habitat	Acres
Confirmed Good	48.58
Total	48.58

Recommendations:
Most of this area is leased to DNR through 2026 as a State Scientific and Natural Area (SNA). Recommend permanent protection through easement, lease, transfer, other protection agreement, or sale.
Habitat Management: Remove woody vegetation by cutting and girdling. Maintain prairie with prescribed burning. Control motorized access to the unit with a gate at the parking lot.

Timeframe:
The county should preserve this area under DNR management for 75 years. Alternately, the county could explore transfer options in order to finance road gravel or an alternate mining site.

Preserve



DNR (USFWS) 1-P: Felton Wildlife Management Area, DNR, (Section 36, Felton Township)

Aggregate Potential:
None documented

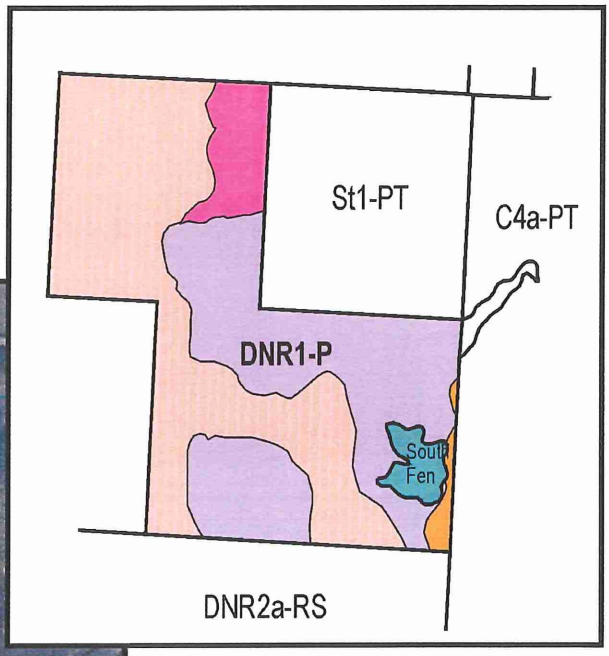
Prairie Habitat Assessment:
Wet and mesic prairie with encroachment of woody species; rare species have been documented. South calcareous fen is within this parcel.

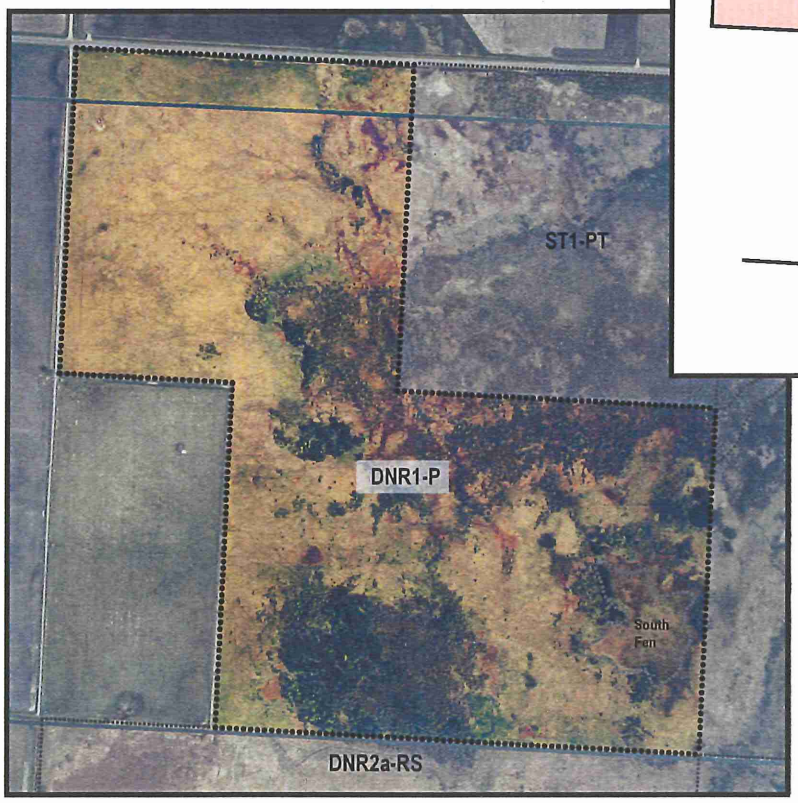
Recommendations:
Coordinate management with other entities.

Habitat Management:
Continue monitoring the fen. Cut or girdle undesirable woody species. Coordinate prescribed burning to maintain and enhance native prairie.

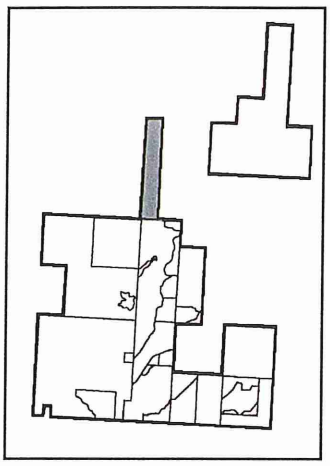
Area Statistics

	Landtype	Acres
	Mesic Prairie (Northwest)	6.52
	Mixed Emergent Marsh (Prairie)	27.34
	Shrub Swamp Seepage Subtype	162.13
	Wet Prairie (Northwest)	193.93
	South Fen	11.79
	Total	401.71





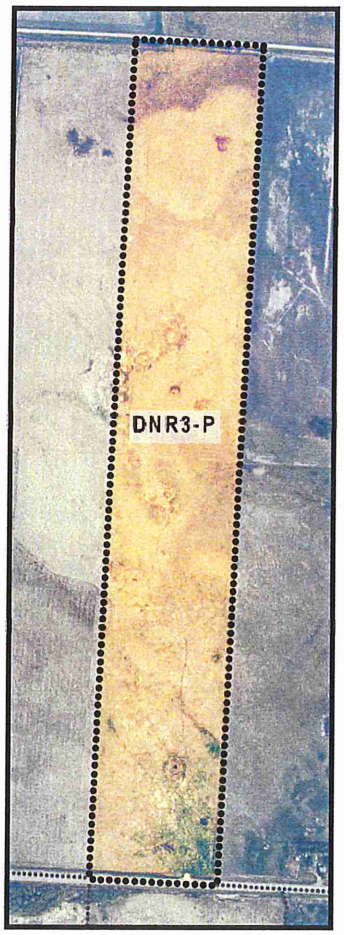
DNR3-P: Preserve, DNR, Felton Scientific and Natural Area, Shrike Unit, (Section 30, Hagen Township)

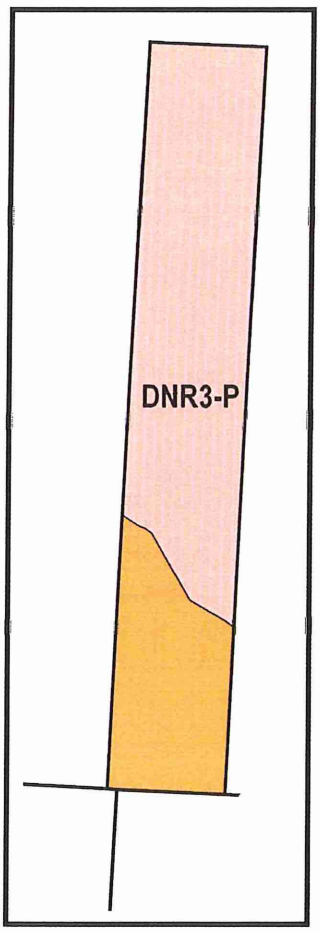


Aggregate Potential:
None documented

Prairie Habitat Assessment:
Area supports mesic and wet prairie. Rare plant species have been found in the wet prairie.

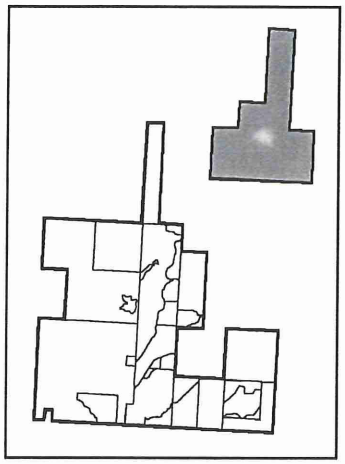
Recommendations:
Coordinate management with other entities.
Habitat Management:
Maintain prairie with prescribed burning or mowing.





Area Statistics

	Landtype	Acres
	Wet Prairie (Northwest)	71.77
	Mesic Prairie (Northwest)	29.49
	Total	101.26



DNR9-P: Preserve, DNR, Felton Scientific and Natural Area, Assiniboia Unit

Aggregate Potential: None documented.

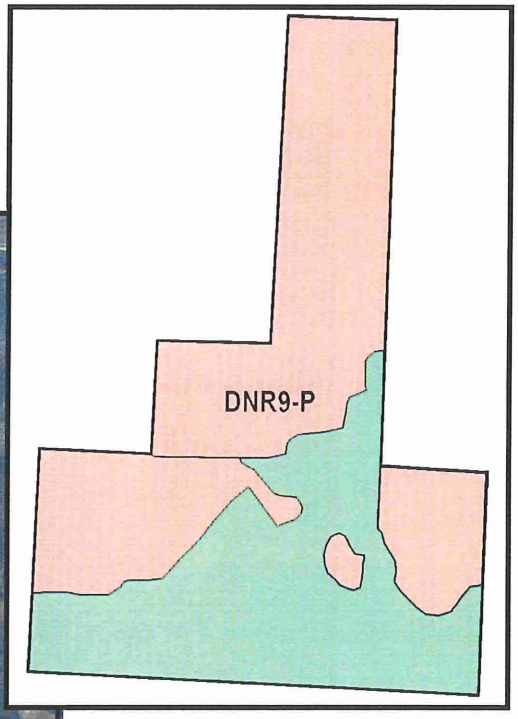
Prairie Habitat Assessment:
Rare species utilize this site. It supports prairie wetlands.

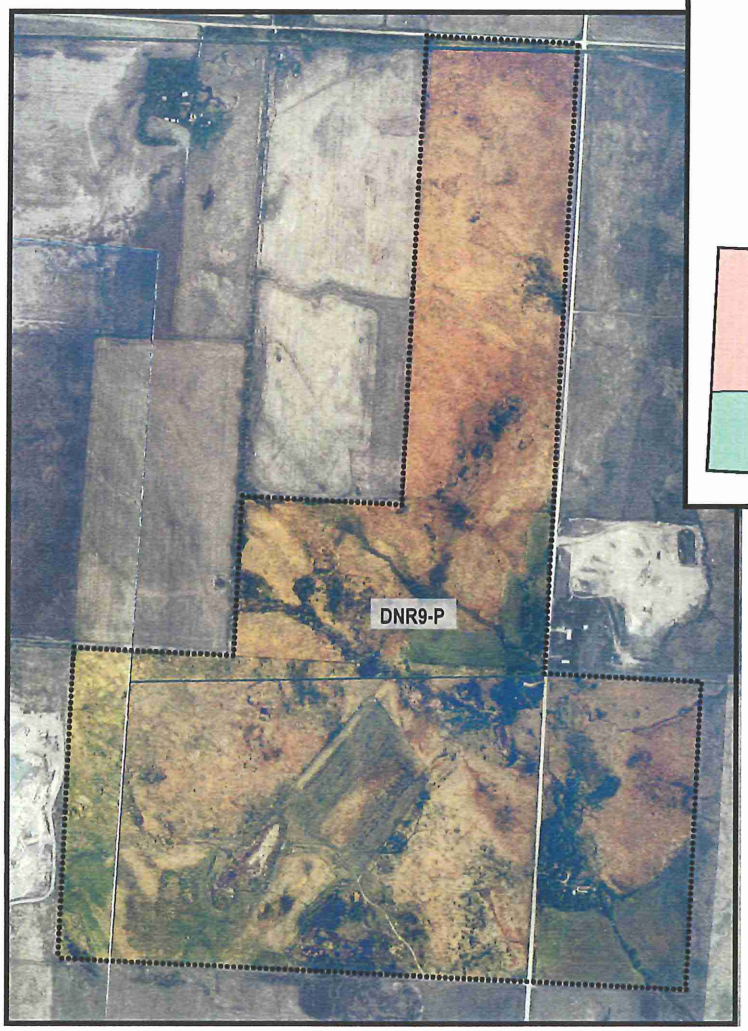
Recommendations:
Coordinate management with other entities.

Habitat Management:
The areas under cultivation or non-native grasses should be restored to prairie.

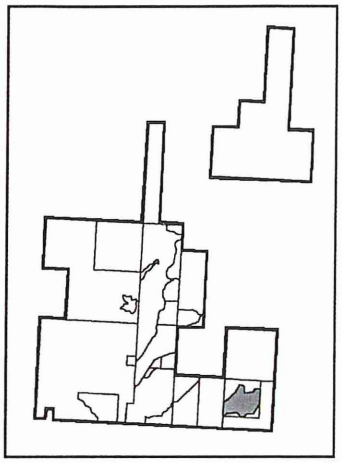
Area Statistics

	Landtype	Acres
	Wet Prairie (Northwest)	290.15
	Grasslands, Cultivated	230.55
	Total	520.70





DNR11a-P: Preserve, DNR Shaw Addition, (SE ¼, Section 5, Keene Township)

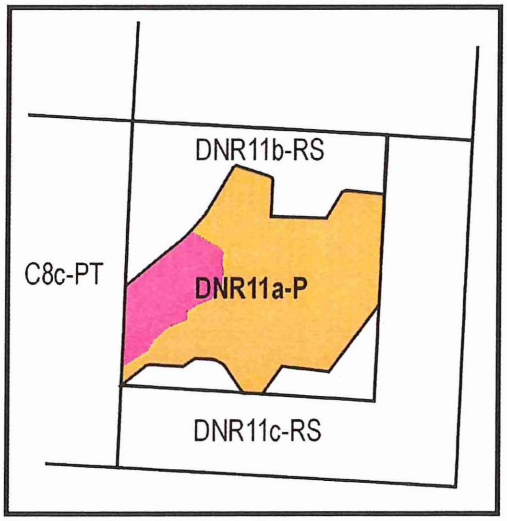


Aggregate Potential:
None documented.

Prairie Habitat Assessment:
Area supports a mixed emergent marsh and high quality mesic prairie. Rare species utilize the native habitat.

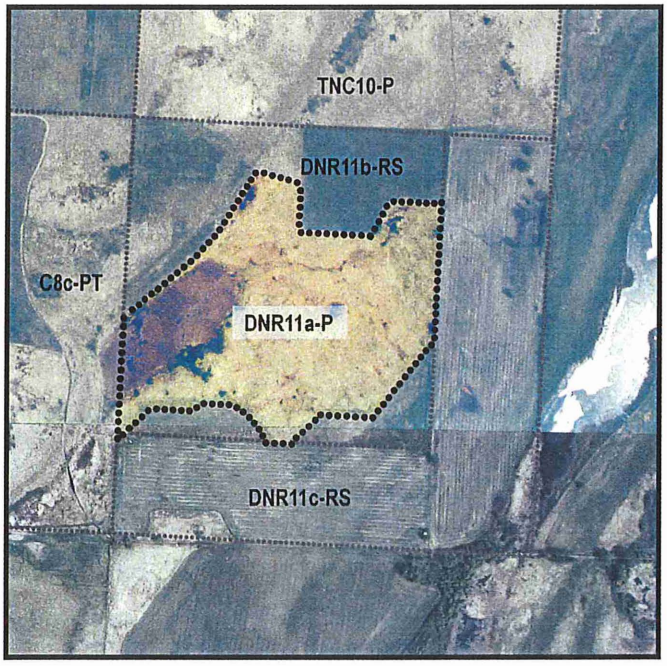
Recommendations:
Coordinate management with other entities.

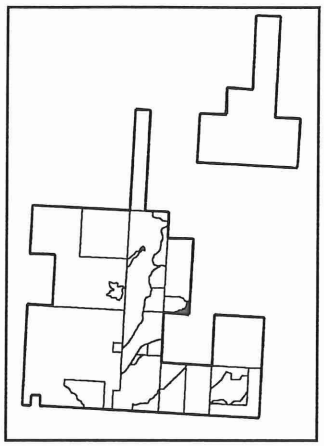
Habitat Management:
Maintain prairie with prescribed burning or mowing.



Area Statistics

	Landtype	Acres
	Mesic Prairie (Northwest)	44.02
	Mixed Emergent Marsh (Prairie)	9.88
	Total	53.90



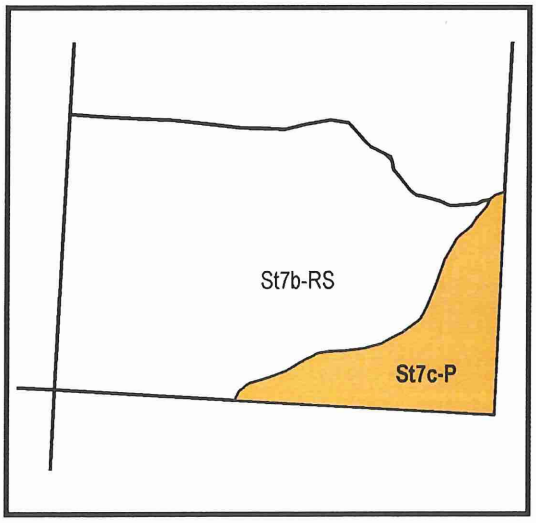


St7c-P: Preserve, DNR, School Trust Fund, (Section 32, Hagen Township)

Aggregate Potential:
None documented.

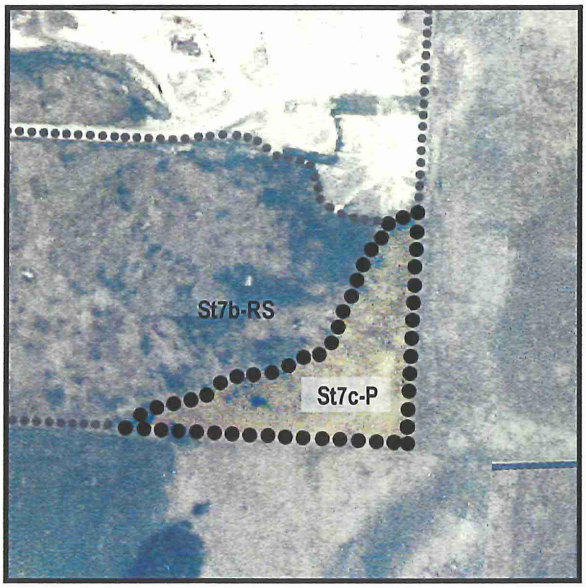
Prairie Habitat Assessment: Mesic prairie currently under lease agreement to preserve, but exhibits some woody encroachment.

Fen Impacts: Mining in the water table range would impact both fens.



Area Statistics

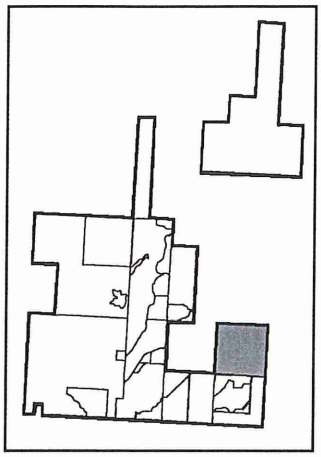
	Landtype	Acres
	Mesic Prairie (Northwest)	5.06
	Total	5.06



Recommendations:
Transfer to WMA after reimbursing the School Trust Fund.

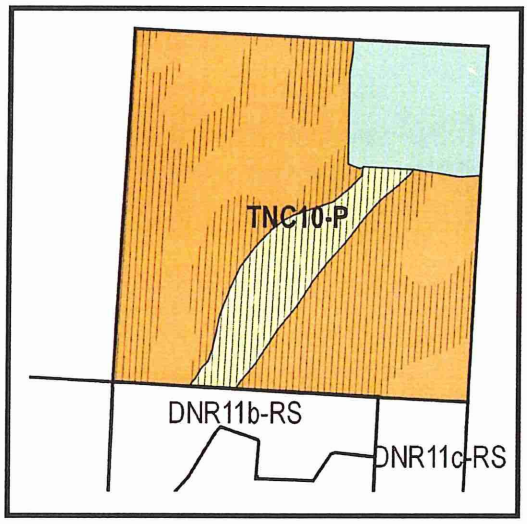
Habitat Management:
Cut or girdle trees. Maintain prairie with prescribed burning.

TNC (DNR) 10-P: Preserve, The Nature Conservancy, lease to DNR (NE ¼ section 5, Keene Township)



Aggregate Potential:
None documented

Prairie Habitat Assessment:
Mesic and dry prairie utilized by rare species. Former agricultural field in NE corner should be reconstructed using native vegetation, preferably of local genotypes.

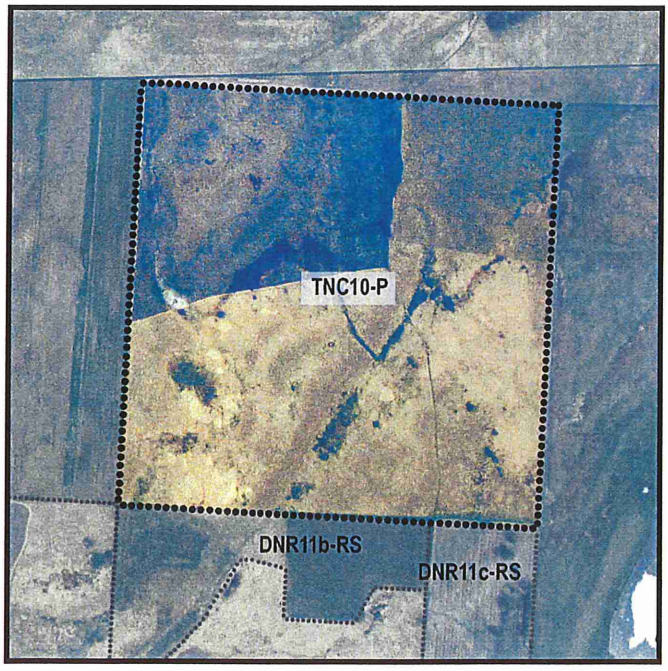


Area Statistics

	Landtype	Acres
	Grasslands	22.77
	Dry Prairie (Northwest) Sand-Gravel Subtype	18.98
	Mesic Prairie (Northwest)	124.53
	Total	166.28

Dakota Skipper Habitat

Habitat	Acres
Confirmed Good	89.64
Total	89.64



Recommendations:
Coordinate management with other prairie sites in the Felton area.

Habitat Management:
Reconstruct former agricultural field with native species. Maintain prairie with prescribed burning.

D. General Resource Management Recommendations

Concepts and activities recommended for individual parcels are described in greater detail below.

Prescribed Burning

Prepare a coordinated burn plan for the Felton Prairie study area. Units should be burned every 4 to 6 years depending on moisture conditions. The wetter sites should be burned more often than the dry prairie sites to suppress the establishment and growth of woody species.

Noxious Weeds

Leafy spurge and Canada thistle occur in scattered colonies throughout the public lands in the study area. However, large infestations (80 acres or more) of leafy spurge on adjacent private lands increase the likelihood of continued invasion and control costs. A coordinated area-wide control strategy should be developed among private and public landowners, the county weed inspector, and other partners.

Haying

The county land should continue to be leased for hay harvest. The combination of haying, grazing, and burning grasslands in the Felton prairie area supports a diverse grassland system. The county's current hay lease could be modified to allow burning, seed harvest, or rest in selected years.

Woody Encroachment

Trees and other woody species have expanded tremendously over the past 50-75 years. Cottonwoods establish quickly on overburden piles and other exposed soils associated with gravel mining. Aspen and willow have expanded with the cessation of haying and fire, especially in the wetter areas. Russian olive, a non-native species is also spreading over the "Zillmer" portion (DNR-1, Section 1, Flowing Township) of the Felton WMA. While burning suppresses woody establishment, cutting and girdling trees may be required for taller, established stands. A coordinated plan should be developed to address existing stands, as well as to prevent new establishment on or around gravel pit areas. No tree planting should be done on any public lands in the Felton Prairie area.

Mine Site Management

Woody and invasive species frequently colonize overburden and stripped topsoil piles. These include cottowood, leafy spurge, Canada thistle, spotted knapweed, yellow and white sweet clover, brome grass and quack grass. A coordinated mining and reclamation plan should develop strategies to reduce the exposure of bare soil by temporary, non-invasive vegetation, or other means.

Roads

In the past, cartways (roads) have been established as needed with little planning or foresight. This has resulted in direct and indirect disturbance of the native prairie. Vehicle use should be limited to the current haul road running north-south from County Road 108 to Highway 34 and access into Bicentennial and Blazing Star Prairie SNA parking areas. Other access points should be gated and fenced (or boulders where practical) for use by authorized personnel and adjacent landowners as needed.

VI. IMPLEMENTATION RECOMMENDATIONS

Through the planning process it became clear that the stewardship plan would not be fulfilled without some direction for the future, for what happens after the report is published is more important than the document itself. The items listed below are those that the committee identified as the most important to follow the planning process.

A. Management Coordination

Like the Beach Ridges Forum, one of the top recommendations of the stewardship committee is continued coordination of resource management for both aggregate and biological resources. The aggregate and rare species are bound together by proximity and do not follow property boundaries. The intermingled resources require coordinated management by various parties if the species and habitat are to survive and the aggregate resources mined without controversy and legal wrangling. Members of the coordinating committee should include representatives of all landowners and managers including Clay County, DNR, TNC, USFWS, Aggregate Industries, and other study area mine operators.

B. Alternate Aggregate Resources for Clay County

If the county wants to maintain its own source of Class 5 aggregate and not rely on commercial providers then it should begin looking for other suitable properties. Expanding the current footprint north could damage the fens and cause mortality to listed species meaning the county would need a fen management plan and takings permit. To avoid these impacts the county will need to mine below the water table starting in 2002. This will increase expenses and the material will be used for a lower value commodity than its potential use as concrete aggregate. Given the environmental considerations, the county might consider selling land with sensitive biological resources and use those funds to purchase less sensitive land for Class 5 aggregate.

C. Continued Education and Research

The lands covered by the stewardship plan offer many opportunities for continued research and exploration. More data is needed to develop a comprehensive groundwater and hydrology model for the calcareous fens and the impact of gravel mining on them. Based on the limited literature review conducted for this plan, more research is needed on the effects of prescribed burning on butterfly populations. Successful restoration of prairie habitat and mine reclamation could contribute to the general knowledge of these activities. The state scientific and natural areas are already used by local universities and colleges for field study and this use should be encouraged.

D. Passive Recreation

Based on the analysis conducted for land use recommendations, the state and county have a tremendous opportunity to cultivate interest in Felton Prairie for sustainable recreation activities like bird and butterfly watching, photography, and star-gazing. In fact these activities could potentially expand our knowledge of the resources at Felton Prairie. The parking lot and interpretive signs off County Road 108 will serve as an important gateway for these activities but much more could be done to improve appreciation for and interest in the prairie and its resources. Currently the area is difficult to locate and navigate for the casual user. On the other hand, more risky activities like swimming and boating are likely to occur without more active management, especially at the State Trust Fund gravel pit. A comprehensive recreation or public use plan for the area should be developed along with appropriate interpretation and facilities. This use has the possibility of directly generating income for service businesses in the area, and indirectly, benefits for the county.

E. CONCLUSION

Felton Prairie is a complex assortment of habitats, minerals, and interests. Some members of the committee advocated a preservation ethic while others stressed the economic benefits of mining the gravel. For all of the reasons outlined in this report and others, the committee attempted to balance preservation, mining, and restoration in a manner that will best meet current and future needs. The conclusions reached here will require continued coordination of land management strategies such as prescribed burning and haying along with monitoring of biological, mineral, and economic resources. This plan was based on the best current science but as our knowledge grows so will the need to revisit the conclusions of this report.

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